

25,530/B/2

FIRST REPORT

OF THE

COMMISSIONERS

FOR INQUIRING INTO THE

STATE OF LARGE TOWNS AND POPULOUS
DISTRICTS.

VOL. II.

LONDON:

PRINTED BY W. CLOWES & SONS, STAMFORD STREET,
For Her Majesty's Stationery Office.

1844.

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II.

SUPPLY OF WATER.

Mr. ROBERT THOM, examined.

Mr. Robert
Thom.

HAVE you paid attention to the mechanical means of supplying towns with water?—Yes.

How many years have you given such attention?—About 30 years.

What towns have you supplied with water by the machinery you have directed or superintended?—Greenock, Paisley, and Ayr have been supplied with water on my plans, and under my own superintendence. Plans and estimates for the supply of other towns, and of many other places, have been given by me, but the duties of my own business of cotton spinning rendered it impossible for me to superintend the details of execution, except in the case of the Rothesay Spinning Mills, the first of my hydraulic operations on a large scale.

Will you state shortly to the Commissioners the principle of your plan, as distinguished from other modes of supplying towns?—I imagine that, in answer to this question, it is enough to describe generally my own plan. The distinguishing features of my plan are, the obtaining some natural basin at a sufficient height, either in itself containing a large supply of water, or into which a great extent of surrounding surface can be drained. Thus a reservoir is formed, which I take care shall be deep enough to maintain the water at a low temperature, and to prevent the breeding of insects and the growth of vegetables; and capacious enough to hold at least four months' supply of water. If it be not possible to obtain a large enough extent of drainage surface at one place, other basins are sought for and form auxiliary reservoirs, the waters of which are conducted into the main reservoir by aqueducts furnished with sluices of a peculiarly simple contrivance. To facilitate the collecting of the water from the surfaces, catch water drains are made use of, and advantage, of course, is taken of any rivulet, spring, or collection of water which may be accessible. From the main reservoir the water is led by an aqueduct to some place near the town, where reservoirs can be formed at such a height that the water from them will rise considerably above the highest houses. There two reservoirs, or, as I term them, regulating basins, are formed, each of them large enough to contain two days' supply of water. From these regulating basins the water is carried into two or more self-cleaning filters, and from the filters into two distributing basins; the regulating

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basins, filters, and distributing basins being in juxta-position, and so arranged that one of each of them may be connected together to form a set of apparatus. Two sets of apparatus are required, that the one may be in use while the other is cleaning or repairing. From the distributing basins the water is carried through the streets by supply of pipes of iron, placed in such a manner as that the water shall always flow in one direction, entering at the higher and wider end and flowing to the lower end; and always kept full of the water at high pressure, so that there may be a supply in readiness for every emergency. These are the principal features of my plan, but its efficiency depends so much on a host of minor details, that if it is thought right I will, in a subjoined note, describe them more fully. I may observe here, however, that although there is nothing remarkable in collecting surface water to fill reservoirs, and in carrying it from these by aqueducts, pipes, &c., for the supply of towns, yet there may be, and often are, in the modes of forming these reservoirs and aqueducts, and in the contrivances to ensure their permanent working condition, such differences, as that while the expense of one method shall form a perfect bar to its adoption, another mode shall recommend itself by its simplicity and economy, and it has been my constant endeavour to unite *simplicity* and *strength*, so as to ensure permanent durability and prevent future expense.

In a letter you have stated, that, "In every case where the distributary basin can be placed high enough, the pipes in the streets ought to be kept constantly full, so as to be always ready at a moment's notice to extinguish fires; and the distributary basin should be placed high enough to send the water over the tops of the highest houses, by merely putting the hose of a fire-engine on one of the fire-plugs, which should be attached to the pipes at short distances through all the streets. This I have done in Greenock, Paisley, and wherever I gave the plans; the advantage is immense; and were it properly and generally practised, there would be little need for insurances from fire. Provision should also be made for cleaning the streets, lanes, sewers, &c., by the water. When the cholera commenced at Greenock, the many dirty streets and lanes in that town were cleansed by a copious supply of water sent down from the Shaw's Water Aqueduct. Hence, in all probability, the few deaths which happened there, compared to those at Dundee, Dumfries, Musselburgh, and other places similarly low and dirty;" is it your opinion that that which was done at Greenock would be practicable in other towns?—It is quite practicable, of course, wherever there is head-pressure enough to raise the water over the houses, whether that pressure is obtained by gravity or by any power. By the gravitating system no additional expense is incurred; but where steam or any other power is used to raise the water, the expense is very great. Hence the unwillingness of water companies, who have to

maintain a mechanical power, to keep their pipes full at high-pressure.

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It is stated that in the city of Philadelphia a similar arrangement has been adopted of keeping the water always on at high pressure; that for the cleansing of the streets a servant girl will put on the hose in the morning, and with this hose sweep the pavement, that once a week a stronger hose is used, and they sweep or cleanse the front of the house up to the highest windows; and that, on an occasion of fire, they immediately apply the hose, and introduce it into the interior of the house, and into the room where the fire takes place; is that an arrangement which you believe, from your experience at Greenock, is generally practicable?—It is perfectly practicable under the conditions noticed in my answer to the foregoing query. It was practised by myself on a small scale 30 years ago.

With respect to the modes of laying the water-pipes for distribution, are there any common defects which you think you have avoided in places, where you have had occasion to superintend the supplies of water?—One common defect is the permitting the water to flow along the pipes in either direction occasionally, thus stirring up the sediment, and sending a stream of turbid water into the houses.

Is that error in distribution a fault which might be prevented in very large supplies, or only in small towns?—It may be prevented in all supplies, whether for large or small towns, if proper arrangements be made at first.

With respect to the filtration of water, have you adopted any peculiar modes of filtration to which you can speak as having been successful in any places where you had the superintendence of the supply?—At Greenock, Paisley, and Ayr, I erected *self-cleaning filters*. The filter that I erected at Paisley is 100 feet long and 60 broad, divided into three compartments, which may either act together or separately at pleasure; so that, when one compartment is cleaning, the other two continue in operation. The site of the filters is on a piece of level ground, excavated to the depth of 6 or 8 feet, with retaining walls all round, joined with cement, and puddled behind, so as to be perfectly water-tight. The bottom is laid about a foot deep with strong, stiff puddle, over which pavement is laid, cemented so as to be impervious to water. The whole of this bottom is then divided into drains or spaces, one foot wide and five inches deep, by means of fire brick laid on edge, and covered with flat tiles of the same material, perforated with small holes, like those used in a kiln for drying oats. These holes are placed very near each other, and are rather more than a tenth of an inch in diameter. There is also a space of a quarter of an inch left open between the ends of the bricks, which support the perforated tiles, and their upper edges are little more than an inch broad, in order that there may be little or no space without holes, and nothing to prevent the

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water spreading equally over every part of the bottom of these drains. This is particularly necessary when the filters are cleaning by the upward motion of the water. The perforated tiles or plates are covered to the depth of an inch with clean gravel, about three-tenths of an inch diameter; this is to be followed with five other layers of gravel, each of the same depth, and each succeeding layer a little finer than the previous one, the last being coarse sand. Over this there is placed two feet deep of very clean, sharp, fine sand, similar to that used in hour-glasses, but a very little coarser; and about six or eight inches deep of this fine sand nearest the top is to be mixed with animal charcoal, ground to the size of a coarse meal, each particle about one-sixteenth part of an inch diameter. There is a longitudinal drain or pipe between the filter and the pure water basin, communicating with both, and on each of the openings between this pipe and the filter, there is a stop-cock to close the communication when necessary. There are also two drains to carry off the foul water when the filters are cleaning, and another to prevent the water from rising too high in the filter. When the filter is complete, its action is as follows:—The sluice and the valve are opened, and the water permitted to flow through the filter into the drain below, until it becomes quite clear. This will take two or three days when first set to work, unless very great pains is taken to wash the gravel and sand before they are put into the filter. The filter will now flow copiously for some weeks (longer or shorter, as the water may be more or less turbid on entering it), and when the quantity passing begins to fall off, the stop-cocks are shut, and the valves are raised. The water then enters *below*, and fills all the drains; and, having a head pressure of several feet, it will force its way *up* through the sand to the top, and in its passage raise the scales or particles of mud which have been deposited in the downward passage, and carry them into the foul-water drain below. If the sand at the surface is stirred by a fine-toothed rake after the water has been thus raised above it, and a little additional water admitted on the top through the conduit, it will facilitate the operation of cleaning, as the mud is always deposited on the *very surface of the sand*. By this means the sediment will be carried off, and the water pass through quite clear again in a few hours; the valves should then be lowered, the stop-cocks opened, and the operation of filtering will again proceed as above described. The cost of this filter was under 600*l.*, and the quantity of water produced *regularly* every 24 hours, is, on the average, 10,632 cubic feet. The expense of a filter, therefore, to give a supply of water of the best quality *for family purposes*, to a town of 50,000 inhabitants, may be safely taken at 800*l.* From often finding pure spring-water in the moors, where the soil for many miles was composed of peat or moss, I suspected there was some substance in the earth which, by combining with the tannin or colouring matter, rendered the water pure, and this was proved

to my entire satisfaction by a careful inspection of the minerals in the hills above Greenock. I there ascertained that the moss water, by flowing over or through a particular species of lava or trap-rock (amygdaloid), became fine spring water. Since then, I have used the substance as a substitute for charcoal, with perfect success and much economy. A very large proportion of the hills above Greenock being composed of this substance, it may be had at a nominal price.

Of what are those filters composed?—They are composed of very fine pure sand, mixed with animal charcoal for the purpose of decomposing any vegetable matter with which the water may be impregnated.

What have you found to be the effect of such a filter?—Besides decomposing vegetable matter as above stated, it renders the water clear, though previously turbid.

Animal charcoal, you seem to say, is the most powerful material?—It is the most powerful agent I know of.

Have you ever contrasted its action with that of ordinary charcoal, or any mixture of ordinary charcoal with other substances? I have.—It is more powerful, and lasts longer than ordinary charcoal.

Are you to be understood to say that you have used ordinary charcoal with other substances?—I have; but finding that it lost its effect sooner than animal charcoal, I discontinued its use.

Have you ever examined chemically the nature of the animal charcoal used; or have you had your attention directed to that point?—I have not.

How long will it last?—Some kinds will last several years.

Did the sand contain any other earthy substances?—No, it was clean sand from the sea-shore.

Pure sea-sand, brown?—Of a lightish-brown colour.

Have you only one stratum of sand?—One stratum, the under part of which is coarse gravel, next a fine gravel, and so on finer and finer to the depth of six or seven inches—and after that the fine sand above mentioned.

Do you put the charcoal in layers, or mix it with the sand?—I mix it.

What head of water have you upon the filter?—A small head of water, about one or two feet at most; the purest water is produced with a small pressure.

From a filter of 6000 feet area you are in the habit of supplying a population approximating to 40,000 people?—Yes; but it depends much on the previous purity of the water.

We should be within bounds by taking half the proportion for a filter of that size?—Yes.

Have you any data as to the quantity of animal charcoal required for a given quantity of water?—No precise data. I use

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the charcoal in about the proportion of one of charcoal to eight or ten of sand.

Do you use the same charcoal over again, after subjecting it to the purifying process?——It might be used again, if it could be separated from the sand.

Have you the power of separating it from the sand?——Not when it is used in the proportion I have stated; and, indeed, it would not be worth while, as the quantity is so small and lasts so long. I have sometimes used charcoal in large layers by itself, and in such cases it might, with economy, be re-burned and used again.

You state in your letter, “Where rivulets or lakes are not in the vicinity, the surface-water alone might, in most cases, be rendered sufficient, if artfully and economically diverted into reservoirs by small aqueducts, as at Rothesay Mills. The average annual depth of rain which falls in Great Britain is probably above three feet; in the west of Scotland it is greatly more; and at Paisley and at Greenock Waterworks, I have ascertained that about eight-tenths of the whole has been made available to the reservoirs. At Rothesay, where the declivity of the ground is less, and its surface more broken and porous, the proportion available is only about six-tenths of what falls there.”——I do so state.

Do you consider that, by proper economy, the surface water in the vicinity of towns and places may be made available to a greater extent than is commonly supposed?——I do so.

Have you calculated what the quantity would be on any given area, an acre, for instance?——I have already stated that, in some cases, eight-tenths, and others only six-tenths of what falls may be collected. It is easy, therefore, knowing the fall in any given place, and the nature of the surface and subsoil, to calculate what quantity a given extent of surface will produce.

Your calculation must depend very greatly on the substratum of a portion of the ground?——Yes, but more upon the smoothness and declivity of the surface. If the surface be smooth and steep, the water runs off so quickly, that little sinks into the earth.

Have you applied your machinery for the supply of small towns, and if so, what is the smallest?——The smallest is Campbelltown, of 7000 inhabitants, which was supplied at a cost of about 2500%. When I speak of a supply, I always mean two cubic feet, or about 13 gallons per diem for every individual of the population.

Are you aware that that is very much below the consumption in London?——I am aware that it is so stated; but as a family supply merely, I rather think it will be found to exceed that of London.

Have you made inquiries upon that point?——Yes.

Do you know what the returns of consumption have been from the water-works in London?——I do not at this moment recollect them, but I have seen them, and heard them explained. Judging

from my knowledge of the facts in other towns, I should say that the quantities set down are rarely delivered. Some years ago, I had the means of ascertaining the quantity supplied to Glasgow, and found that it did not amount to 13 gallons for each, and of which nearly one-fourth was suffered to run waste, from the imperfect state of their works. In Perth, the quantity supplied to each individual was only 8 gallons. In Greenock and Paisley, where the pipes are kept constantly full, and there is nothing to prevent the people from using what they please, the quantity taken is less than 12 gallons for each. These facts lead me to question reports, which state the family supply beyond 13 gallons per diem. In London, doubtless, the quantity used for watering the streets, for public works, and the like, must be very great.

Have you come to a conclusion as to the practicability of applying machinery to towns still smaller?—Yes. At Campbelltown, a family of five individuals will be supplied for about 1*s.* 4*d.* per annum. The cost at Ayr for the same quantity is 2*s.* 2*d.*; at Paisley, it is 2*s.* 9*d.* In Greenock, I think, it is about 2*s.* 6*d.* I allow in this case 5 per cent. on the capital employed; the expense of wear and tear, charge for superintendence, and the like, being always included in my estimate.

Are all those high-pressure services reaching to the tops of houses?—Yes.

Having all the advantages of being enabled to put out fires, and supply the cisterns at the tops of houses?—Yes.

You allow, besides the 5 per cent., as much as will keep the machinery in complete order?—Yes.

In those towns there is an acclivity, a hill, which gives you a high reservoir?—Yes.

In cases where a town is on a dead flat, would it be possible profitably to raise the water by mechanical force for application to the several purposes of extinguishing fires, and washing streets and houses, and so on?—I think it would.

Have you ever had occasion to estimate the expense of such a mode of supply, as compared with the ordinary mode?—I have, but I have not the statement with me.

The supply of water for the different towns you have referred to has been from very different distances?—Yes.

The expense has been, of course, increased by the distance?—It has certainly, but to a very small extent. If you go farther from a town, land is generally cheaper, and there are fewer interruptions to the operations. The cost of making the reservoir is the same, or nearly the same, at whatever distance it be. The increase of expense, therefore, arises from the increased length of the aqueduct only, which is a trifling item in the calculation for the supply of a town. At Greenock, where the aqueduct passes through rugged and impracticable ground, and was a work of no ordinary difficulty, the cost of it was only about 400*l.* per mile, exclusive of the

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price of the land, and it is capable of passing a full supply for a city of 500,000 inhabitants.

What is your practice in laying down water-pipes, and in distributing water for the attainment of the object of keeping the water cool?—The situations for the reservoirs, basins and filters, being obtained, as above described, I proceed to notice some details of practice which are peculiar, and on which part of the success of my plan is dependent. In making the aqueducts for conveying the water from one reservoir to another, or from the reservoir to the basins, the ordinary practice is to take the most direct line between the extremes; crossing valleys by aqueduct bridges or embankments, and overcoming the many other difficulties which attend the method by equally expensive expedients. My method is to wind along the slopes, however far it requires me to go about, descending only with such a fall as will allow the water to flow with a gentle current. I endeavour to select the course of the aqueduct, so that it may form the main drain of the farms, and be a fence between portions, which it is advisable to keep separated,—possessing, too, the advantage of affording drinking places for the cattle, the aqueduct is, by the farmer, esteemed rather a benefit than otherwise. The details of the formation of the reservoirs, embankments, sluices, and regulating apparatus, cannot be well understood without illustrative figures. The filter I have described in a previous answer. I shall, therefore, proceed to notice some peculiarities in my manner of laying the service-pipes from the distributing basins. These pipes are of iron, and, as has been already noticed, are laid so that the water shall always flow along them in one direction, entering at the higher end, and proceeding to the lower end. At the lower end of each range a cleansing cock is fixed, which is opened occasionally to clear out any rust or mud which may have accumulated in the pipe, and which, if allowed to remain, would, of course, deteriorate the quality of the water. The pipes, I have said, are constantly kept full; in addition to the advantages already detailed, as attendant on this, I may mention the following:—There is no limit to the quantity that the poorest inhabitant may take at all times. There is no risk of turbid water being carried into the houses by the water rushing along empty pipes every time it is set on. The pipes are laid under ground to a minimum depth of three feet under the surface of the pavement; where they can conveniently be laid deeper it is done; the water is thus kept cooler and of finer quality, and risk of injury from frost is avoided. In some cases, in order to afford private houses very fine cold water, I sink an iron cistern to hold about 20 gallons, 8 or 10 feet below the bottom of their cellar, and supply it with water by a small lead pipe entering its top. Another small pipe is inserted at about four inches above the bottom of the cistern, and carried up to the cellar where the water is to be drawn

off. Thus, for an expense of about 5*l.*, a family is supplied with one of the greatest luxuries which can be enjoyed—pure sparkling ice-cold water.

Do you lay your pipes so near the kerb-stone as to leave a distance sufficient for carriages to pass?—Yes, except in old towns where the streets are very narrow.

Do you think that considerable improvements may not be made in laying down water-pipes, so as not to inconvenience passengers?—I do.

Can you state to the Commissioners any results as to the administrative machinery by which the supplies to poorer districts in respect to purity and cheapness may be facilitated?—I am not prepared with any other plan than that described already, and which, generally speaking, might, in my opinion, be applied with advantage to the smallest towns as well as the largest.

You mentioned that you had seen animalcule in the water in particular parts of Scotland; in what parts have you seen them?—I have seen them wherever the water was shallow and warm.

Have you seen it with the naked eye?—Yes, but more distinctly, of course, with a microscope.

You have seen animalcule also that are visible to the naked eye?—Yes.

Can you state anything with respect to the temperature of the water in which you have seen them?—I have not noted the precise temperature.

Have you used steam or water-power in any case, or in all cases been able to take advantage of the natural level?—I have found it better in every case to go further and bring the water from higher grounds, than to use steam-engines.

What pressure has the head of water had in cases where you have used machinery?—I have not raised water by machinery.

To what altitude have you raised it?—I have raised it to a considerable height.

Have you formed in your own mind a deliberate conclusion as to the amount of altitude you should have beyond the height to be supplied to give it full power?—Yes.

What altitude do you consider it necessary to give?—For the supply of houses merely, it is enough that the water will rise to the top of the highest; but for security against fires, the water should have a pressure sufficient to throw it with great force over the highest house. At Greenock, there is a pressure of 250 feet, which is 150 feet above the surface level of the highest street.

What height will that throw it?—To any height that will ever be requisite.

Supposing you had a dead level, and wished to send the water to such a height to extinguish fire in houses, what head should you have?—Not less than 20 feet above the house; less might do, but more is better.

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Have you had your attention at all directed to the preventing the bursting of water-pipes in winter, beyond the fair protection which the walls of buildings would afford?—I lay the pipes so low under ground, as to prevent their being affected by the frost. Where that cannot be done, some non-conducting envelope may be used.

You have never applied artificial heat to such a purpose?—No, I have found it better and cheaper to resort to other means.

The question referred to places where the pipes, from the nature of the buildings, are very much exposed?—It would be easy to send steam through them, if required, but I have never found it necessary.

From your experience, can you say that in all cases where it is necessary to form an artificial reservoir for the purpose of obtaining water, it can be done with the utmost security and safety; will there be any danger of the bursting of the embankments?—None, if they are properly constructed, and of proper materials. The construction should be such as to prevent the water penetrating under or amongst the materials, and it should be formed with a slope in front, on the side next the water, of about four feet of base to one foot perpendicular. An embankment of this construction the water has no *tendency* to overthrow, as the vertical pressure much exceeds the horizontal pressure.

What was the nature of the accident which occurred at Greenock?—An ill-constructed embankment gave way, and by the torrent of water let loose, 40 lives were lost, and damage done to property to the extent of 6000*l.* or 7000*l.* In this embankment the face next the water was very steep, and no care had been taken to make it impervious to water or vermin; the consequence was, that moles and water-mice had perforated it like a riddle, during the drought in search of water; and when the flood came and raised the water above these holes, it rushed through them with such force as to sweep away the embankment to its base in a few minutes. About three years before the accident, I had constructed an embankment on my principle on the same stream lower down. This embankment was not injured by the rush of the waters when the other was swept away by it.

Have you found any difficulty at Greenock, when there is a considerable pressure on the reservoir, of keeping the stop-cocks in good repair?—No.

What sort do you use?—Of the ordinary construction, carefully made and well fitted, and with more surface than usual.

Have you found the science of hydraulics very complete for practical application to these purposes?—Very complete; but few of those who are employed in such works know much about it; and those who understand it will rarely apply it to practical uses.

Have you any further observations to make?—I may repeat, that I am clearly of opinion that no town ought to be considered

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fully supplied with water, unless the pipes are kept constantly full, and arrangements made by which a powerful force of water can be taken from them at a moment's notice, to extinguish fire in any part of the town, high or low. But this, I fear, will be found impracticable without the assistance of Government and the Legislature. So powerful are many of the present Water Companies, so strong the chain of interest which binds them together, and so large is the capital sunk in the present imperfect works, which the improved system would supersede, that I despair of ever seeing certain towns properly supplied with wholesome water, unless the powerful aid of Government and the Legislature are brought to bear down their selfish opposition. And it were clearly better, even to impose a local tax to compensate such companies, than that the health and comfort of the community should continue longer to suffer by withholding from it the first necessary of life—a copious supply of pure water.

Suppose Government were to select a strong case, and procure an Act of Parliament, not only to supply the town with water, but also to ensure it against fire, levying a local tax upon all the property or buildings in the town to defray the expense?—From the consideration I have long given this matter, I am satisfied that such a scheme, skilfully planned, and judiciously and economically executed, would work well, pay well, and prove an immense boon to the whole community. With such assistance or patronage I would myself be willing to take shares either with the corporation, for behoof of the community (which, in my opinion, is decidedly the preferable plan), or with any respectable company able and willing to undertake it.

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ARE you a civil engineer?—I am.

Are you employed by the East London Waterworks Company?—I am; and also by the Kent and the Vauxhall Waterworks Companies.

Are you well acquainted with the mode of supplying different places with water?—I am.

Have you calculated what would be the abstract cost of lifting a certain quantity of water, say 1000 gallons, 100 feet high, supposing the engine set up and all the establishment fixed?—I have gone into those calculations, but each case must have a different calculation. No general rule can be laid down for it. I will take two towns. The town of Hull, where the corporation are going to enlarge their works, having just obtained an Act of Parliament for that purpose. Hull is a very flat town; the works will be about half a mile from the outskirts, and the whole supply of water will be raised by steam engines. At present they raise the water about 40 feet: it is proposed to raise it about 120 feet above

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the town. The extent of the proposed pipeage will be about 40 miles; the supply will be for about 110,000 or 120,000 inhabitants; in this case the whole of the water must be raised by steam machinery, and having no elevated ground, and having to raise water by mechanical power in a stand-pipe, the head of water is limited to a certain extent, and the head of water being limited, the sizes of the mains must be proportioned to the limited head. Now, in Cork there is a very large river, and ample water-power there, and steam-power will not be required for above six weeks out of the twelve months; the cost, therefore, of carrying on these works, as far as the machinery is concerned, will be less. There is also elevated ground close to the city, where it is proposed to erect the water-works 280 feet high. The water can be raised immediately by the natural power of the river to a very great elevation; and thus the sizes of the pipes will require to be much less than if the elevation were less, so that the estimate for the same work at Hull would be very different from the estimate for the work at Cork; and in almost every town the circumstances vary. In some cases a supply may be obtained by going a little distance from the town; the source may be so elevated that no machinery will be required to lift the water. At Kingston, in Jamaica, they have within four or five miles a fall of about 600 feet, so that the expense of supplying Kingston will be comparatively very small, as no machinery will be required to raise the water. In fact, in almost every case there must be a variation according to its circumstances.

Supposing you are on a dead level, and you have to raise water into a reservoir close above the engine, what would be the cost per 1000 gallons for raising water every 50 or 100 feet?—That would depend upon the kind of engine that you use, and the price of coal. In my first report to the corporation of Hull I stated, “The annual consumption of coals will be in the following proportion: for 6000 houses, 180 tons; for 13,000 houses, 390 tons; for 20,000 houses, 600 tons.

Have you prepared a statement of the cost of raising water to a given altitude, under different circumstances?—At the request of the Commissioners I have prepared the following statements of the cost of raising water:—

1st. A single pumping engine, made by Boulton and Watt in 1809, working 10½ hours per diem, 6 days per week, mean power 29½ horses; quantity of water raised per diem, equal to 612,360 gallons, 100 feet high; the cost of coals 12s. per ton. In the estimate for the cost all charges for coals, labour, and stores, are included, but no charge for interest upon outlay, or repairs of machinery and buildings; all other charges for working the engine are included.

Cost of raising 1000 gallons 100 feet high	s.	d.
Or, Cost of raising 22,099 gallons 100 feet high	0	0.543
	1	0.

This estimate is made upon an average of two years' working.

2nd. Two single-pumping engines, made by Boulton and Watt in 1809, working 24 hours per diem, 7 days per week, mean power of each engine 30½ horses; quantity of water raised per diem 2,922,480 gallons, 90 feet high; the cost

of coals 12s. per ton. Labour, stores, &c., taken as in the first case. The estimate made upon an average of 10 years' working.

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	s.	d.
Cost of raising 1000 gallons 100 feet high . . .	0	0·358
Or, Cost of raising 33,519 gallons 100 feet high	1	0·

3rd. Two single-pumping engines, made by Boulton and Watt, one in 1816 and one in 1828, working 12 hours per diem, 7 days per week, mean power of each engine 76 horses; quantity of water raised per diem 3,601,116 gallons, 100 feet high; cost of coals 12s. per ton. Labour, stores, &c., as before. The estimate made upon an average of 10 years' working.

	s.	d.
Cost of raising 1000 gallons 100 feet high . . .	0	0·333
Or, Cost of raising 36,036 gallons 100 feet high	1	0·

4th. One single-pumping engine, made by Harvey and Co., upon the expansive principle, in 1837, working 24 hours per diem, 7 days per week, mean power 95½ horses; quantity of water raised per diem 4,107,816 gallons, 110 feet high; cost of coals 12s. per ton. Labour and stores as before. The estimate made upon an average of 4 years' working.

	s.	d.
Cost of raising 1000 gallons 100 feet high . . .	0	0·150
Or, Cost of raising 80,000 gallons 100 feet high	1	0·

The foregoing statements of the cost of raising water with different engines will show that there is a great variation. The comparison, however, is favourable to the engines upon the old plan, as those quoted are good ones. The following table will show the variation more clearly:—

To raise 160,000,000 of gallons of water 100 feet high, it would cost—

According to the 1st statement	£362
Ditto 2nd ditto	238
Ditto 3rd ditto	222
Ditto 4th ditto	100

In raising large masses of water of course you raise it comparatively cheaper?—Yes; but for each case you must make a different estimate.

In your report, in speaking of the supply for Cork, you say “Provision should be made for an increased quantity of water per individual, for an increase of what is termed waste,” but which term I do not consider as strictly correct, as the water that runs away through the narrow streets and alleys, inasmuch as it cleanses them from filth, increases the health of the neighbourhood, and cannot therefore be strictly called waste water. Again, you say “the power which I intend the new works to possess, of giving a supply to the upper floors of houses and buildings, will lead to an increased demand for water for water-closets; and when manufacturers can obtain a supply in the upper parts of their buildings, without having to incur the expense of pumping it up, they will be induced to take a larger quantity.” Have you any data to show the comparative economy to the public of having water forced up to an elevation systematically and regularly, as compared with the expense of carrying it up by hand?—No, I have not any calculation with me, but I have not the slightest doubt that in raising large quantities of water by machinery it can be done at infinitely

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less expense than by manual labour. I believe that they are paying now in some neighbourhoods about London from four-pence to eight-pence a barrel for water which has been brought from a distance. At Hampstead I believe they pay about eight-pence. I suppose the highest cost by the water companies is considerably under a penny. I find, upon reference to a paper entitled "Observations on the Past and Present Supply of Water to the Metropolis," written by me in 1835, that, according to the Parliamentary Returns in 1834, the amount received by the water companies in the metropolis was at the rate of three-fourths of a farthing per 36 gallons, and it is stated, "In some of the suburbs of London water is still supplied by carriers; where it is carried in buckets from wells, it is sold at the rate of eight-pence per 36 gallons, or 42 times as much as when supplied by machinery; and when it is carted from the river, at four-pence per 36 gallons, or 21 times more than machinery." In the same paper it appears that, in A.D. 1582, the supply of water to the metropolis, by means of the London-bridge Water-works, was 3,170,000 imperial barrels per annum, about seven-eighths per cent. of the supply afforded by the water companies in 1833, namely, 357,288,807 barrels per annum.

Will you have the goodness to state what you consider the best mode of supplying the poor with water, whether by a common stand-cock for several houses, or by a separate supply to each house, and at what cost a copious supply might be furnished by either of the two modes?—If the supply were given by a municipal body, or by Government, and all houses, excepting those of the poor, were rated, then I am of opinion that the best mode of supplying would be by common stand-cocks, so constructed that when the water was required it would be necessary to hold the valve up, to keep it open, and when the supply was obtained the valve should shut of itself, and remain closed until water was again required—this would prevent waste. As all houses, excepting those of the poor, would be rated, they would undoubtedly have a separate supply for each building; but if the supply were given by a trading body, and numerous common stand-cocks were erected (and they must be numerous, I conceive, to effect the desired object) to supply the poor, I think it is certain that a very large proportion of the inhabitants of a town would send their servants, or several would join together and employ a man to bring the water from the common cocks, or public fountains, to their houses, to avoid paying rates to the water company. A copious supply of water to the poor can, in my opinion, be given by a public body only, for supposing that in towns at present supplied by trading companies a supply were required for the poor, and that each parish were rated high enough to raise a sufficient sum annually to pay for a given number of common stand-cocks, it would be a very difficult

matter to prevent the inhabitants generally from taking a supply from the cocks, and if this were not prevented the rental of the company would soon be reduced. Supposing, however, the supply to be given by a public body, then, as one common stand-cock would, if in supply during the whole of the day, probably be sufficient for 100 houses, the expense of laying on the water would be considerably less than if each house were supplied separately. The cost of giving a copious supply must depend upon the locality, as the expense of obtaining the water is dependent thereon.

What would be the probable increased expense of a constant supply of water for the prevention of fire being kept on, either by elevated reservoirs, or by the mechanical power of the steam-engines?—The following reasons why a constant supply in all the iron pipes laid down, both mains and services, is impracticable, and which I have extracted from my Report to the Pipe-Water Committee of the Corporation of Cork, may be worthy of attention:—“Although it is proposed to give a supply to each house *every* day in the week, instead of three times a-week, as at present, nevertheless it is not to be a *constant* supply during the twenty-four hours; for, if such a plan were to be adopted in a city so large as Cork is, the sizes of the mains must be very large, and the waste of water would be excessive. The plan proposed to be adopted is to supply only portions of the city at one time by means of services; and thus in the principal streets mains will be laid, through which the water will be conveyed from the source, and, branching from these mains, smaller pipes will be laid, called services; at every point where the services branch from the mains a cock will be attached, for the purpose of opening or shutting off communication with the main; from the services small lead pipes will branch to each dwelling-house, and whenever the communication is opened with the mains, which will always be charged, the houses, whose lead pipes are joined on to the services, will receive a supply of water. The necessity for such an arrangement will be made obvious by the following statement:—When water is forced through pipes, either by a natural or artificial head, or by steam, or other power, friction is created in proportion to the velocity of the water, and length of the line of pipes. As the distance increases, the power must either be increased or the velocity reduced; the shorter the distance, the less the power required to overcome the friction; if, therefore, it is necessary to exert a great power to force the water to the extremities of an extensive district, that they may be properly supplied, it is very evident that the power which is exerted near the source, not being required to overcome so great an amount of friction as at the extremities, must be applied to increase the velocity of the water through the orifices near the source; and if, therefore, such an arrangement as the one herein-before-mentioned were not adopted, the effect would be that those

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houses which were near the source would have a superabundant supply, while those at a distance would have a very small supply, if any; but by means of the system mentioned, when the inhabitants near the source have received their supply, the cocks on the services are shut down, and the water in the mains passes on to supply the services at the extremities, which will have a sufficient supply, because the water, not being used before, must pass on to the extremities. That each may have an equal supply, those that are near the source have the communication opened with the main for a shorter time, than those at a distance, in proportion to the velocity with which the water is delivered. In addition to this, on every line of mains and services, orifices about two inches diameter are made at certain distances, which are filled up with what are termed 'fire-plugs,' being nothing more than wooden spigots made to fit the orifices; these are easily fitted, and as easily removed, and in case of a fire they are started, and a supply is given directly. The strength of this supply is regulated by means of the system before mentioned. Thus, by closing the service-cocks in the other parts of the district, the whole force of the water may be concentrated in that part where the fire has occurred. As the elevation which the water will be at in the proposed summit-reservoir will be very great, I propose to erect stand-pipes in several parts of the town, with a screw to which a hose can be attached, and, the pressure being very great, the necessity for fire-engines will be dispensed with in the middle and the lower parts of the north and south sides of the town; the protection thus given against fire will be greater than at any other place that I am at present acquainted with. I am, however, about to construct reservoirs on Woolwich-common and Blackheath for the protection of the Government establishments at Woolwich, Greenwich, and Deptford against fire, upon the same principle as the plan herein proposed to be executed for the city of Cork. In laying down the mains the general rule to be followed is to take care that the distances between them shall not be too great, because, if it be so, it will be necessary to have services of larger diameters than would otherwise be necessary, to prevent loss in pressure, occasioned by friction, or it would be necessary to keep the communication between the mains and services open for a longer time to give a supply to those houses at the extremity of the service; in fact, the same argument that has been used in the case of the mains would apply to services of too great a length." As I consider this a question of great importance, I will add to the foregoing remarks. Suppose a supply of water to be required for 20,000 houses, and the height to which it was raised at the works was such that a 20 inch main would be sufficient to give the supply according to the system herein-before explained—it would not be so if the water were constantly on in all the pipes, both mains and services; for example, suppose the size of the lead pipes to supply the houses

to be upon an average half an inch in diameter, then the aggregate areas of 20,000 half-inch pipes would be equal to $27\frac{1}{4}$ square feet, and it would require a main of 71 inches diameter at the source to supply the town, instead of 20 inches; and for side streets, containing 100 houses each, it would require pipes of 5 inches diameter, instead of 3 or 4 inches. This is an extreme case, but one that it would be necessary to provide against; because, if the water is always on, the houses may be all at one time supplied; and, even trusting to the chances of only one-half the number of houses taking water at the same time, the main must then be 48 inches in diameter at the source. In addition to the necessity for this extraordinary outlay in the first instance, the quantity of water that would be used would be enormous, and, consequently, the expense of raising a sufficient supply would be increased in proportion, and the object sought, that of having a strong pressure of water in the mains, would be defeated by the very means proposed to insure it; for, inasmuch as the water in the pipes would be always on, so would the draught by the houses be constant, and the present power of shutting off the supply from the side streets, and applying the full force of the supply to the particular locality requiring it, would be destroyed. Again, if separate mains were laid from the works to be used as fire-mains only, the expense would be nearly the same, as that of the system of pipes for supplying the inhabitants, and this item, which forms the greatest part of the outlay of a waterworks, would be nearly doubled. The foregoing remarks have been made upon the supposition that it is proposed to give a supply which would render the use of fire-engines unnecessary. If it were proposed to increase considerably the present force of the water in the water-mains of the metropolis, it might be done, first, by taking up the present pipes, and laying down larger ones, the expense of which would, I imagine, render it an impracticable scheme; or, secondly, by raising the water at the different works under a greater pressure, say under an extra pressure of 100 feet. Now, taking the supply to the metropolis, as stated in the Report of the Select Committee of the House of Commons in 1833, at 35 millions of gallons daily, and supposing the increase since 1835 for the whole of the metropolis to be, as in the East London district, viz., 30 per cent., the present supply will be equal to $45\frac{1}{2}$ millions of gallons daily. To raise this quantity 100 feet extra in 15 hours (upon the average) would require an extra power equal to 1536 horses. The outlay required would be about 130,000*l.*, and the increased annual cost of coals, supposing the most economical pumping engines to be erected, would be 6500*l.* per annum, supposing the cost of the coals when delivered to be 13*s.* per ton. This sum is equivalent to a capital of 130,000*l.*, at the rate of 5 per cent. The total amount of capital to be sunk would therefore be, for machinery and coals only, without reference to stores, labour, and repairs, 260,000*l.*; and even if this sum were

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expended, the increased force obtained would not render the use of fire-engines in a great many parts of the metropolis unnecessary, and therefore no very great benefit would accrue. In provincial towns, however, and most especially where works are not yet constructed, the increased safety to be obtained by raising the water to a sufficient height, and properly proportioning the iron pipes, will be very great. Where the locality is favourable there is no doubt that the use of an elevated reservoir is the best mode that can be adopted for giving a supply. Much may be done, however, to insure a better supply for the metropolis in case of fire, and especially for such large public buildings as the Houses of Parliament, the large Government offices, the Tower, the docks, railway stations, &c., where an expenditure of money is not so great an object as in private establishments. If in the first place the parishes were to erect stand-pipes in places where fire-plugs now are, and if these stand-pipes had brass screws, to which a hose might be speedily attached, in many places the force of the water would be sufficient to supply without a fire-engine; and in every place the supply to the fire-engines would be much more abundant if the hose were laid directly to the engine, and the power required to work the engines would be less. And if these stand-pipes had keys to them of a different construction from those used by the turn-cocks for the supply of the district generally, one objection to the parish authorities having the direct command over the supply of water would be removed; and if, in addition, a heavy penalty could be enforced in all cases when these cocks were opened for any other purpose than for a fire, I imagine there would be no objection to the plan; and in some cases additional safety would be thus obtained by increasing the number of keys. As regards large public buildings, I conceive the best protection may be afforded in almost every case where the size of the establishment will warrant the necessary expenditure, by the adoption of the plan hereafter described. In almost every part of London, where there are large public buildings, the pipes of some of the metropolitan water companies are laid, and an abundant supply of water may be obtained at a *low elevation*, although the pressure in the mains may not be sufficient to force the water to the tops of the buildings; and in almost every case there are sewers in the same neighbourhoods. Now if a small overshot water-wheel were erected, and a pipe from the water-mains laid on, to supply it when it was necessary to use it, and which might be done instantaneously; and if this wheel worked force-pumps, to supply water to a system of pipes distributed through the buildings, and on these pipes, in suitable situations, screws were fixed to which a hose and nozzle might be attached immediately, then there would be a powerful stationary fire-engine, which could be set to work instantaneously by the servants, watchmen, or police belonging to the establishment. Part of the water required to supply the wheel would be raised by the pumps, and the remainder would run into the sewers.

If an arrangement such as the one now proposed were properly made, greater protection would be afforded in the event of a fire than could possibly be given by any other means; for the time required to set the engine to work would be merely that occupied in turning the water on. No time would be lost in sending for the fire-engines, nor in getting up the steam, as would be necessary if a steam-engine were employed.

Have you formed any opinion as to whether, in towns not already provided with waterworks, it would be an advantage to place them under the control of the municipal body, instead of a trading body?—There can be no doubt, I imagine, if the management is equally good, that in many instances water may be supplied at a much cheaper rate by a municipal body than by a trading company, provided the capital could be raised at a low rate of interest, which it would most probably be, as the security would be the borough fund, which I presume in most instances would be considered good.

Do you think that a great economy might be introduced in the power employed in pumping the water by the use of some improved kind of engine?—A very great economy may be introduced by the use of the expansive-engine and plunger-pump, the advantages of which have been felt in the mines of Cornwall for 30 years or more, although I believe it was not introduced into waterworks establishments until the latter end of 1837, when an engine upon that principle was set to work at the East London Waterworks, and is now working most satisfactorily, having from the time of its first starting continued to raise 225 barrels of water with the same quantity of coals that the best engine on the works, made upon the old construction, required (and requires) to raise 100 barrels. Since that time another large engine of the same description has been erected at the Southwark Waterworks, whose performance is equally good, if not superior. The comparison above given is too much in favour of the old engines and against the new, taken as a class, as there are instances in London, and in the country, where the quantity of water raised by the consumption of a given quantity of coals is not more than one-fourth or one-fifth of that raised by the new engine. There is another way of showing the advantage to be derived from the introduction of this new engine; namely, that the same quantity of water may be raised from two and a quarter to five times the height by the consumption of a given quantity of coals; and as the size of the pipes depends upon the velocity of the water passing through, and as the velocity increases as the square root of the head of water, so by increasing the head of water four times, the sizes of the pipes may be reduced to one-half, and the chief item in the expenditure in new works may consequently be reduced one-half, and thus less capital will be required; and, as it often happens that it is more convenient to spend a small sum annually than a large sum at once, this is a matter of great im-

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portance. And again, in many, if not most towns where the works have been established for a long period, and the length of pipeage has gradually been much increased, the pipes originally laid down become inadequate to afford the increased demand, the consequence of which is, that the extremities of the district are generally supplied most miserably. Instead of having to lay down new and large mains, the erection of the new engine, by which the head of water may be increased at the same cost of coals, increases the utility of the old mains, and prevents the necessity of a large outlay in new ones.

Are there any modes resorted to for gauging the quantities of water supplied?—There are no good meters that I am aware of for measuring the quantities of water. The only way we can get at it is by approximation. Parties that require a large supply of water say, We have a tank of a certain size, or two tanks of a certain size, and we require them filled so many times a week; and we measure the cubical contents of those tanks; or if it be a supply for a steam-engine, we can make an approximation, and estimate the quantity that will be wanted.

Have you seen an instrument called the water-meter?—There is no water-meter that will measure water delivered under pressure that I am aware of.

Have you seen that which has been used in some towns in Scotland under the name of a water-meter?—No. The difficulty is this:—you can make a water-meter that shall measure the quantity of water delivered from one vessel to another without pressure; but you want a meter which you can put upon a pipe when the water is entering a house. In a large manufactory, or any other place where the consumption is great, the water is generally supplied to the upper floors; you have therefore a delivery of water under pressure, and I know of no meter that will register the quantity of water delivered under these circumstances with such accuracy that there could be no dispute as to the quantity delivered; or at such moderate cost as would induce parties to purchase one under the expectation of economising water to an extent that would warrant the outlay. A meter made upon the principle of a high-pressure steam-engine would measure accurately; but the size of such a machine, and the cost of it, would be too great.

Is it your opinion that for new towns and provincial towns an arrangement, by which high pressure shall be constantly kept on the water for use in case of fires, is practicable and desirable?—In new towns, in the principal streets, mains should be laid, and from those mains services should branch to the side streets; the mains should be always charged with water. The services only charged when you require the water to be used for the houses, but in case of fire, you turn the water on immediately, or as soon as the turncock is there, into the services. In the East London district, at every fire the turncock is called for, and he is generally there in five

minutes after he is summoned, and then a good supply is given to this one street; but if all the services were on, the supply would be very poor, as it would not be concentrated.

Supposing it was during the night when the people were not drawing water, would not the services be as efficacious as if they were shut off?—Yes, but we find in London, and I believe elsewhere, that they draw water at night; for if the water in the tanks has been (as will be the case) reduced during the day, the ball-cocks will of course be open at night, and there will be a great draught created.

Do not you think that compensating cisterns might be erected in different parts of the city, which would always compensate for any water that might be drawn at a time?—There is no doubt that if you can get those cisterns, which would be elevated reservoirs, it would answer the purpose, but they must be very large cisterns, and at a very considerable height.

Would not the cost be much less than the cost of having much larger mains?—It might be, but if you are to supply a large fire, you must have very large cisterns.

Have you made any estimate of how much a large fire would consume?—I have in one or two cases; but it is evident that as the quantity supplied must depend upon the extent of the fire, no criterion can be formed of the quantity required. According to the present system, however, there is much more wasted than used at a fire.

Is not it the practice to protect manufactories in the North by having a cistern at the top of the building, from which, upon the occurrence of fire, with pipes properly arranged, they can bring a hose to bear upon any one room?—If the fire is below, you can get a pressure of water upon it; but if the fire is near the tank you have no effective pressure. The great desideratum in putting out a fire, is not so much the quantity of water as the force with which it is supplied. If you can send the water with pressure upon it at the commencement, a very little will put it out. At the same time there is no doubt that large tanks of water upon large buildings afford considerable protection.

May you not have a tank upon the roof so as to bring the pressure to bear upon it, supposing it to be 15 or 20 feet, or any given height above the room?—If you have a tank large enough, and you have got it 20 or 30 feet above the place where the fire is, it will be no doubt of great advantage.

Have you seen any report of the arrangements in use in Philadelphia for the supply of water for the inhabitants?—I only know generally how the supply is given. They are supplied, I believe, very economically by water-wheels, and the pumps are inclined.

Have you seen the arrangements proposed for the supply of water for New York?—No.

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Are you aware that at Philadelphia this is the practice; that every day the hose is screwed to the main or pipe in front of the house, and the pavement washed with it, and that once a week, or at certain times, it is the custom of the inhabitants to wash the whole front of the house up to the highest windows, and that upon the occasion of fire the hose is attached and applied immediately, and that that arrangement is ready at all times, night and day? —I am not aware of that fact.

And that at New York it is proposed, by similar arrangements to those at Philadelphia, to supersede fire-engines entirely? —Then they must have an elevated reservoir, or the machinery must be kept at work constantly.

One gentleman, Mr. Thom, of Greenock, has stated to the Commissioners: "In every case where the distributary basin can be placed high enough, the pipes in the streets ought to be kept constantly full, so as to be always ready at a moment's notice to extinguish fires; and the distributary basin should be placed high enough to send the water over the tops of the highest houses, by merely putting the hose of a fire-engine on one of the fire-plugs, which should be attached to the pipes at short distances through all the streets. This I have done in Greenock, Paisley, and wherever I gave the plans. The advantage is immense; and were it properly and generally practised, there would be little need of insurances from fire." Have you seen any of those instances, and are you aware of any reason why the same arrangements by artificial reservoirs may not be generally applied to a town? —I agree generally with what Mr. Thom has said; with this difference, that in a large town you could not serve the whole of the pipes. If he means the mains, then I should agree with him entirely. The mains ought always to be charged, especially when you have an opportunity of getting an elevated reservoir.

Taking a large town as an aggregate of several towns, may you not do for a large town what is actually done for several provincial towns? —The objection is this: that if your water is always on, you would have to supply a much larger quantity of water than is now necessary to give an abundant supply, and you must have a great many extra officers to prevent improper use of the water. If you can insist upon every inhabitant having a ball-cock, and if you can be satisfied that there would be no unnecessary waste and no unfair dealing in the houses, then the objection to having all the pipes charged is removed. But if you cannot do that, you are very likely, at the time when you have a fire, instead of having the water concentrated at the place where you want it, to find the water drawn off in different parts of the town.

Are you aware what is the amount of the annual loss by fires in the metropolis, where there are some six hundred fires every year; and have you compared that loss with the extra charge which would be incurred by having such an efficient arrangement for a

supply of water to the whole of the metropolis, as is adopted in some particular provincial towns?—I am not; but I believe that if you made the calculation in the way suggested, and took the actual loss that occurs from fires, it would appear to sanction an enormous expenditure in making works.

Have you any doubt that at such a town as Liverpool a practical arrangement to secure supplies of water, and to bring them to bear in a few minutes in case of fire, would be an enormous economy?—Certainly it would.

With respect to the supplies of water to the inhabitants in the poorer districts, does not the supply of water by a company render the use of separate tanks necessary, which would not be necessary in the case of a supply by the public, or by an agent for the public; in a provincial town, for example, would there be the same necessity for having separate tanks, if the municipality took the supply of water in hand, that there is in London, and in districts which are supplied by water companies?—Decidedly. They take the quantity that they pay for. The works are calculated to give a certain quantity of water to each house, and the inhabitants pay in proportion to the quantity that they take; if they took double, the pipes would not be sufficient to give the supply. You would, therefore, require the same restrictions that you have at present.

In houses in small courts, supposing you were to have the water always on, could not you make a more economical arrangement as to tanks, by making one tank in some cases supply all the houses?—It is not unfrequently the case, where there are a number of houses in a court, that either a common cock or a tank is provided. If it is cheapest to put up a tank; it is put up, and is supplied.

It is stated to be a regulation enforced by penalty that no person shall supply from his butts any of his neighbours, necessitating of course each house having a separate tank?—That is not always the case; for instance, in London you do not collect the rates from the poor. Where a landlord has got 20, or 30, or 40, or 50 houses, and requires a supply of water: if they are poor houses it is frequently given by one common stand-cock to all the houses. If he was to put a separate supply to those houses by a lead pipe, the lead pipe would be there in the evening, but it would be gone in the morning. But he puts a common cast-iron cock, so that there is nothing worth stealing; and the parties go to this, but the poor people have not a separate one for each house, because it is too expensive.

Are those depredations committed by the inhabitants or by chance thieves?—I cannot tell; in the East London district we have above 500 of those common cocks supplying several houses.

Are the common tanks or receptacles for water in general well kept, or does the soot and dust collect in them from their being open to the air?—We supply above 50,000 tenants, and I do not think that during the last 14 years we have had six complaints

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of bad water ; we have occasionally three or four complaints in a week of stoppage of water. Sometimes the plumber has beaten the pipe in ; sometimes there are complaints by manufacturers that they do not get a sufficient supply. We inquire into those, and we generally find that the manufacturer is getting a much larger quantity than was agreed upon.

May not complaints of the quality exist to a greater extent than come to the knowledge of the Company?——I think not : there are above 12 collectors, 12 or 13 turncocks and foremen and inspectors, all of whom are constantly about the district. When complaints have been made that the quantity of the water has been bad, we have been perfectly satisfied beforehand if there was one tenant that complained out of a hundred in the same street, that the cause was not in the water, but in the cistern, and on examining the cistern we have found a rat or a cat, or we have found that the cistern has not been cleaned for a long period, or perhaps a tenant has left the house and another tenant has come in, and the tank has in the interim been neglected.

How often do you think the cisterns are cleaned?——I do not know. I should think they ought to be cleaned about once a fortnight.

All these cleansings of vessels in which the humbler classes keep their water, are done by the individuals—it is not the business of any public officer?——No ; we look after the water which is distributed. I will state what is done in the East London district. There are about 400 miles of iron pipes ; half of these pipes are probably in supply at one time, and while the water is at rest in the other half, deposit takes place ; the pipes are, in fact, settling reservoirs, and any matter mechanically suspended in the water will settle in the pipes. Now it is the duty of the turncock, before he gives his supply to any street, to start the end plug of the service for three or four minutes to let part of the water run out so as to get rid of the deposit, and if that is followed up regularly, as I believe it is, there is no reason for complaint of the quality of the water.

Where is your water taken from?——From the river Lea, near Lea-bridge.

Do you filter it in any way?——No ; we have about 20 acres of settling reservoirs.

How are the settling reservoirs constructed and arranged?——We take the water in by a canal about two miles in length ; that comes into a wide canal or small reservoir, at the end of which there are two sets of gates ; one communicating with one reservoir, the other communicating with another reservoir. We admit the water into both reservoirs. We then draw it out of one reservoir while the second one is kept closed ; the next day we draw it out of the second one and fill up the first one. During the time of floods we have the means of shutting off the water altogether for four or five days from those reservoirs.

How do you get quit of the matter that settles below?—The deposit accumulates very slowly. About 12 or 13 years ago we cleaned out two small basins; I think they had not been cleaned out before for 15 or 16 years; with regard to our large reservoirs, which have been made since 1836, I have no idea that in my time we shall have to clean them out.

What is the area of these large reservoirs?—One is $6\frac{1}{2}$ and the other $5\frac{1}{2}$ acres.

You do not find much deposit in the water?—No; I should think ten months out of twelve our water is limpid.

It appears that at Cork you rate small houses at 1s. in the pound, and large houses at 6d. in the pound; what is the reason of the difference of the charge?—In my own table the variation is from three and a half per cent. upon the large houses, to five per cent. upon the smaller houses; the reason is, that though the rental in one case is very small, they want a large quantity of water, and though the rental in the other is very large, they do not want an increased quantity of water in proportion.

Upon the whole, the people in the lower grade pay less per gallon for the water than other people pay?—Yes; taking what they use.

In the east of London the number of houses that you supply is 50,000, and there are 50,000 tanks or water-butts through the district; those tanks or water-butts are of course kept with various degrees of care or carelessness, and they must be exposed to soot and to dust;—is not it to be inferred that with the best coverings given to those butts or tanks in a large town, there must be deterioration by dust in addition to the constant accumulations of sediment?—It varies in degree; of course there must be some, and there is no doubt that such is the case.

Are there any tanks now constructed so air-tight as to exclude dust or soot, and the other impurities brought into a large town?—When a tank is filled with water, if it is left to rest, a deposit will take place; that remains at the bottom; but the water is drawn off at two or three inches from the bottom; soot and dust generally remain on the top, and float as a scum upon the surface; now if the water is drawn off so that the top and the bottom meet, then you make it bad water, but otherwise it will not be bad, because you neither draw from the top nor from the bottom; and if people take ordinary care to clean out the butts, and if they wish it, there is no reason why they should not clean them out every day or once a-week, as there is always an abundant supply: they will always have clean water, but it must depend upon the inhabitants themselves.

Have you compared the state of the water at the supply with the state of the water previously to its departure from the reservoir?

Yes; the water that is given in the houses is clearer than the

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water in the reservoirs, and for the reason I have alluded to, that our pipes are in fact settling reservoirs.

Are there insects in the water in hot weather?—Not that I am aware of; I have not seen any.

How would it do to have a small orifice so constructed that, with a constant pressure on, it should deliver a certain quantity of water in twenty-four hours; that there should be a cistern capable of containing that quantity of water, and that people might draw more or less, as they thought proper?—I think it would be practically impossible. Every orifice out of 50,000 or 20,000, must be of a different size, depending upon the distance of the works, the size of the main through which it is sent, and also depending upon the number of houses taking water from that pipe at one time; and in the next place, unless the pipes are mathematically true, the quantity to be delivered could not be fixed, and every small lead pipe must vary in diameter, not only according to the distance the tank was from the iron pipes, but according to the regularity or irregularity in laying down. In fact, I consider it practically impossible.

The question takes for granted that the pressure is kept up equally over all the pipes?—It cannot be—it is physically impossible.

Has it ever occurred to you to consider whether the expense of laying on water in houses might be economised, or whether any considerable quantity of lead pipe might be saved if it were done by a public body?—Supposing the water was supplied by a public body—a municipal body—and they were to purchase their lead pipes in large quantities, and to lay them on to each house, they would supply them cheaper no doubt than the plumber would because they would require no profit.

Might not small iron pipes, or even earthenware pipes, be frequently used instead of small lead pipes for the supply of the inferior class of tenements?—Earthenware pipes could not be used; iron pipes might be used; but if they were wrought iron perhaps they would corrode. I do not know what the result of a comparative calculation would be as to the expense with reference to their duration.

In supplying the inferior districts in London, have you occasionally laid iron pipes?—The landlords have laid iron pipes.

Do you happen to know the duration of those pipes?—No.

Are you aware of any difference in the quality of the water passed through iron pipes, as compared with the quality of that passed through lead?—Both in iron pipes and lead pipes a coating very rapidly takes place in our district; that coating is, I believe, a carbonate of iron and sulphate of lime in the one case, and, I believe, carbonate and sulphate of lead in the other, which forms a thin crust round the inside of the pipes, about the thickness of a thick

sheet of paper, and as soon as that is formed, being an insoluble salt, no further corrosion takes place; but the corrosion is upon the *outside* of the pipe when it is of iron, and that depends upon the quality of the ground.

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You are clear that if water was laid on by the public at large instead of by every occupier having his own pipe, the expense might be very greatly economised in the poorer classes of houses? I have no doubt of it, because it would be upon a large scale.

Have you any notion to what extent there might be a saving?—
—I have not.

THOMAS HAWKSLEY, Esq., C.E., examined.

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As an engineer, have you given much attention to the modes of supplying towns with water, and have you, besides superintending the construction of some works, had under your direction the greater part of the supply of water to the town of Nottingham?—I designed and constructed the Trent Water-works at Nottingham in the year 1830-31, and am resident engineer at this time. I have also been employed by several other Companies.

What is the number of houses to which water is supplied from the works which you superintend at Nottingham?—About 8000, containing a population of about 35,000 persons.

What is the greatest pressure at which water is kept upon the pipes supplied?—The greatest pressure is about 120 feet, and that on a considerable portion of the town. The average pressure may be stated to be about 80 feet, there being in Nottingham great variations of altitude.

Is the high pressure kept upon all classes of pipes and at all times?—Yes, upon all classes of pipes; the principal main, the district main, the street service pipes, and the tenants' communication pipes.

By the term tenants' communication pipes, do you mean the smaller lead pipes which are within the houses, and that upon these there is the common and constant high pressure night and day?—Yes. We have no use for the term high pressure. It is the ordinary state of the water within the pipes. The pipes are charged so as to deliver water to the tops of all the houses which are within a proper distance beneath the head of water in the superior reservoir. High service is the term used by companies who supply water to a certain height, say to the first floor; and who levy an additional sum from parties for whom they force (by the higher service or pressure) the water up to more elevated stories.

Does the high service occasion much additional expense?—The extra cost of pumping to raise the water to the

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highest points for which it is ordinarily required is very slight. There is but one pressure at Nottingham, and that is the same at all times, and is found to be economical. If the water were lifted only half the height the saving would not amount to more than about 1-20th of the total charge.

Then with the tenants' service pipes full at all times, and in constant communication with the mains and chief reservoir, you dispense with the necessity of the tenants having water-tanks?—Entirely. All the houses that have been supplied since the Trent Water Company has been established, which are very numerous (indeed, probably amounting to 5000 or more out of 8000) are without water-butts. In the houses taken by the Trent Company from the former Company, the tenants of which became tenants of the Trent Water Company, there were brick cisterns under the floors already existing; of course we only attached the old communication pipes to the service pipes of the new Company, and so far as the majority of those tenants are concerned we do supply the tanks, for they existed before; but even in many of those cases the tanks have been abandoned, and the tenants take their water in the same way as others.

It is stated that under the common arrangement of having water "on" for such a time on alternate days as may fill butts and tanks that of the total capital invested in the complete machinery, the portion of the tenant's outlay consisting of the house butts or tanks, ball-cocks and pipes involves the expenditure of a capital equal to that invested by the Company; for example, if the Company's capital amount to 50,000*l.* for engines, mains, &c., the tenants' capital invested for tanks, ball-cocks, and pipes will involve an equal expenditure, and that half perhaps of the tenant's portion will consist of the expense of the tank, butt, and ball-cock?—The expense of the tank or butt will in general be more than half the tenant's expense considered exclusively of the cost of the communication pipe used in the street, which is at Nottingham provided and maintained by the Company, but probably not otherwise.

Is the branch pipe which goes to the tenement in each case included in the Company's capital in the calculation you speak of?—It is provided by the landlord in most towns. In some towns it is not provided by the landlord. At Nottingham it is a work done at the expense of the Company; the Company takes on itself the whole of the pipes which are laid in the public highways. With that portion of the pipe which extends within private property the Company have nothing to do. Under their Act of Incorporation I think they could not legally expend their capital in extending pipes on private property.

In the capital of a Company, do you include the pipe to

each of the individual houses?—I should say not. In general that would be the tenant's charge; but in the case of Nottingham it constitutes only a small portion of the expense of works; it costs the Company about a shilling a foot on the average, including taking up the street, putting down the pipe, and enclosing it, and may amount to between 2000*l.* and 3000*l.* The cost of each of the Company's branches may possibly average 15*s.*, but as one branch will in the majority of instances supply a whole court, the cost per tenement supplied will not exceed 6*s.* or 7*s.* It will be observed that the cost of branches is worthy of a more attentive consideration than it generally receives, and ought to have much influence in determining the construction and arrangement of the smaller works of distribution. This expense ought *always* to be borne by the Water Companies, who would then frequently prefer laying a smaller service-pipe on each side of a wide street to a single larger one in the centre. The existence, or the danger of the introduction, of a rival Company, operates powerfully to induce public companies to keep down all *visible* charges, and to this end they throw as much as possible of the burden of investment upon the party supplied. It is a fact, though as yet hardly recognized as such, that the public companies much need the protection of an authority competent to judge and determine in all cases of dispute arising between themselves and the public. The present system of legislation, which leaves the companies and the public to themselves, is creative of adverse interests and of consequences which, though excessively injurious to both parties, are by far the most detrimental to the public. Many Water Companies would be glad to take upon themselves the expense of laying on water, *especially to the poorer classes*, provided they could *secure* a fair return on the necessary investment by a *visible* addition to the charge for the water supplied; but this security the companies cannot obtain so long as Parliament shall prefer the ill-working check of interested rivalry to the disinterested control of a national authority.

That expense is therefore not included in the amount of the Company's capital?—In the case of Nottingham it is, but not elsewhere *generally*.

With reference to the calculation you have given of tanks, ball-cocks, branch pipes, and so on on each individual private person's premises, you include in the Company's capital the entire substitution for them?—Yes; I think I may perhaps better explain it in this way: the expenditure at Nottingham for the supply of 8000 houses amounts to about 30,000*l.* I apprehend that the cost of butts or cisterns fitted with a ball-cock, pump, or draw-off cock, and other appurtenances would also amount to 30,000*l.* at the least if, as the questions

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imply, each of the 8000 tenants were to be provided with a separate cistern or tank capable of containing water for two days' supply after the present rate of consumption, and that of more than half this cost the public is disburthened by the introduction of the system of constant delivery.

Then by the arrangement of keeping the pipes constantly full, dispensing with the necessity of tanks, you would get rid of more than half the tenants' expense, or more than one-third of the then total expense of introducing water into houses?——
Yes; certainly.

It is a complaint in respect to the poorer districts where the population are actively occupied, that the cleansing and proper care of their receptacles for water, or butts, is greatly neglected, and that they become sources of impurity; they are not properly covered; that soot and dust get in; that in summer time they are frequently exposed greatly to the action of the sun, and the wooden butts are apt to decay. All labour of cleansing these causes of impurity is prevented by the arrangement of keeping the pipes constantly full?——
Yes; it may be said that the effect of this arrangement is to substitute one large reservoir or tank well situated and under effectual care, for the many thousand ill-placed butts and tanks requisite to afford a copious supply on the common arrangement.

Are there not other conveniences and economies attendant on such an arrangement as that in practical operation under your charge at Nottingham, and stated to be in operation in some other towns?——Yes; there is the saving of the room occupied by the tank, which is in some districts of much importance; there is the avoidance of the damp from the evaporation of a body of water in the house, the saving of accidents and of leakage, and of the inconvenience from having the tank sometimes empty. In many houses, where there is no convenience for a tank in the upper part of the house, it is placed in a lower apartment, and the water must be borne up stairs for use; the labour incurred necessarily restricts the free employment of the water for many purposes to which it might be beneficially and healthfully employed. In such places, too, the expense of a force-pump to charge tanks for water-closets, and of waste and warning-pipes, is sometimes necessary. This apparatus for the middle and higher class houses is not only very expensive but liable to be often out of repair, constantly bringing the plumber into the house. Another and a very serious inconvenience affecting the habits and sanatory condition of the population attendant on the system of partial or occasional supply is, that it creates an inconvenience and an obstacle to the use of baths. With a

constant supply of water at sufficient pressure baths might be supplied in private houses with little difficulty or expense, so little, indeed, that I believe it to be practicable, and hope yet to see baths introduced into the houses of labouring men for the use of themselves and families.

As an abatement to the economy from dispensing with the use of the water-butt and tank and its machinery, must not the tenants' communication pipes be much stronger and more expensive to bear the constant pressure?—If anything there may be a *saving* in the tenants' outlay for pipes. These pipes in the metropolis and other places, where the Companies' supply is only occasional, are larger than necessary that the water may be delivered within a short time. In towns the usual size of the tenants' pipes is three-quarters of an inch, and in the larger houses one inch; whereas with the constant supply half-inch pipes will serve the same purpose. If necessary we can have stronger pipes of the same weight. Pipes of half-inch diameter and two-and-three-quarter pounds weight per foot are found to be secure at the strongest pressure employed in Nottingham.

In some evidence given on this subject by Mr. Wicksteed, the engineer of the East London Water Company, he states, that "if such a plan (*i. e.* of having the tenants' communication-pipes constantly full to the highest parts of the town) were to be adopted in a city so large as Cork is, the sizes of the mains must be very large, and the waste of water would be excessive." He afterwards illustrates this opinion by the following hypothesis:—

"Suppose a supply of water to be required for 20,000 houses, and the height to which it was raised at the works was such that a 20-inch main would be sufficient to give the supply according to the system herein-before explained, it would not be so if the water were constantly on in all the pipes, both mains and services; for example, suppose the size of the lead pipes to supply the houses to be upon an average half an inch in diameter, then the aggregate areas of 20,000 half-inch pipes would be equal to $27\frac{1}{4}$ square feet, and it would require a main of 71 inches diameter at the source to supply the town, instead of 20 inches, and for side streets, containing 100 houses each, it would require pipes of 5 inches diameter instead of 3 or 4 inches. This is an extreme case, but one that it would be necessary to provide against; because if the water is always on, the houses may be all at one time supplied; and even trusting to the chances of only one-half the number of houses taking water at the same time, the main must then be 48 inches in diameter at the source. In addition to the necessity for this extraordinary outlay, in the first instance, the quantity of water that would be used would be enormous, and consequently the expense of raising a sufficient supply would be increased in proportion, and the object sought, that of having a strong pressure of water in the mains, would be defeated by the very means proposed to ensure it, for inasmuch as the

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water in the pipes would be always on, so would the draught by the houses be constant, and the present power of shutting off the supply from the side streets, and applying the full force of the supply to the particular locality requiring it, would be destroyed." Again, the opinions following are stated in the answer to the several questions put—
Q. Are you aware that at Philadelphia this is the practice; that every day the hose is screwed to the main or pipe in front of the house, and the pavement washed with it; and that once a-week, or at certain times, it is the custom of the inhabitants to wash the whole front of the house up to the highest windows, and that upon the occasion of fire the hose is attached, and applied immediately, and that that arrangement is ready at all times night and day?—*A.* I am not aware of that fact. *Q.* And that at New York it is proposed, by similar arrangements to those at Philadelphia, to supersede fire-engines entirely?—*A.* Then they must have an elevated reservoir, or the machinery must be kept at work constantly. *Q.* One gentleman, Mr. Thom, of Greenock, has stated to the Commissioners—In every case where the distributary basin can be placed high enough, pipes in the street ought to be kept constantly full, so as to be always ready at a moment's notice to extinguish fires; and the distributary basin should be placed high enough to send the water over the tops of the highest houses by merely putting the hose of a fire-engine on one of the fire-plugs, which should be attached to the pipes at short distances through all the streets. This I have done at Greenock, Paisley, and wherever I gave the plans. The advantage is immense; and were it properly and generally practised, there would be little need for insurance from fire. Have you seen any of those instances, and are you aware of any reasons why the same arrangements by artificial reservoirs may not be generally applied to a town?—*A.* I agree generally with what Mr. Thom has said, with this difference, that in a large town you could not serve the whole of the pipes. If he means the mains, then I should agree with him entirely. The mains ought always to be charged, especially when you have an opportunity of getting an elevated reservoir. *Q.* Taking a large town as an aggregate of several towns, may you not do for a large town what is actually done for several provincial towns?—*A.* The objection is this; that if your water is always on, you would have to supply a much larger quantity of water than is now necessary to give an abundant supply, and you must have a great many extra officers to prevent improper use of the water. If you can insist upon every inhabitant having a ball-cock, and if you can be satisfied that there would be no unnecessary waste, and no unfair dealing in the houses, then the objection to having all the pipes charged is removed. But if you cannot do that, you are very likely, at the time when you have a fire, instead of having the water concentrated at the place where you want it, to find the water drawn off in different parts of the town."

Now what does your observation of the actual fact and experience enable you to state to be the case as to these several hypothetical or scientific deductions, and first as to the actual waste of water; what is that at your works?—

A judgment may perhaps be best formed as to the small

extent of waste from a statement of the actual amount of supply. The actual amount of supply at Nottingham is not more than from 80 to 90 gallons per house per diem; this is taken by about 8000 tenements and works of every description, amongst which are breweries, dye-works, steam-engines, and inns, and other places of large consumption.

Does the system of constant supply equalize comparatively the rate of delivery?—It diminishes the rate of delivery in the service-pipes and sub-mains very materially, distributing over a greater number of hours the quantity of water which otherwise must be delivered in a very short period. The word “equalize” does not apply, because the current of water in the great leading main is but little affected.

It is spreading the supply over the 12 hours of the day?—Yes, and with the advantage that as the water travels more slowly through the pipes, smaller pipes will be equivalent to larger.

Is what is usually called the “waste of water” prevented in your works by an extra number of men?—The fact is directly the reverse. The constant supply is the means of a large economy of men. Our company has maintained its supply by night and by day ever since its establishment, except during a period of one month, when for the purpose of experiment the water was shut off at 10 in the evening, and turned on again at 5 in the morning. It was then found that it would be more expensive to keep extra turncocks, do extra repairs to valves, draw plugs to cleanse the pipes, and attend to complaints. The original plan was therefore resumed. We find that one experienced man, and one boy of about 18 years of age are, on the system of constant supply, quite sufficient to manage the distribution of the supply to about 8000 tenements, and keep all the works of distribution in perfect repair, including cocks, main pipes, service pipes, and the tenants’ communication-pipes, to the extent they are laid under the public highways. The Old Company has adopted the system of the Trent Water Company, and now maintains a constant supply. Any company that possesses an ample quantity of water at its works, and a sufficient reservoir in an elevated situation, may adopt this mode of supply without difficulty or disadvantage, and indeed the difficulty and disadvantage is far from insuperable when an elevated reservoir cannot be obtained.

The term waste would imply an excessive expense for the pumping of water. Now it appears, from one instance, cited by Mr. Wicksteed, of the duty of a steam-engine of good construction, that this one single pumping engine, upon the expansive principle, and with coals costing 12s. per ton, with labour and stores, and all except the interest on fixed capital,

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the cost of raising 80,000 gallons of water 100 feet high was 1s.; that by another, Taylor's Cornish engine, 1 lb. of coal converted into steam raises 10,000 gallons of water 10 feet high: in other words, if a room 20 feet square were filled 4 feet deep with water, 1 lb. of coal converted into steam would overcome the friction of the engine, and raise that water into a room 10 feet above it. Does your own experience justify the conclusion from such instances, that when the machinery and distributing pipes are fixed, and there is an unlimited supply of water, as from a river, the expense of pumping additional quantities is inconsiderable as an element of calculation?—Assuming the possibility of varying our works without cost, the experience at Nottingham is to this effect, that we could give 8 or 10 times the present unlimited supply for about a double charge; that we could raise all the water now taken 50 feet higher by increasing the charge 5 or 6 per cent., and that were we to lower the head to half its present height, the saving of expense would not exceed 6 or 7 per cent. on the gross charge to the tenant. The answer may be otherwise given thus. The Trent Water Company supply houses at an annual average charge of about 7s. 6d., at any level required, even into the attics of four or five story buildings; if the supply were afforded to the level of the pavement only, the charge could not be reduced more than 6d. per house, or for the labourers' tenement not more than 4d.

It is stated that the daily supply of the metropolis is equivalent to a lake of 50 acres of a mean depth of three feet,—what, on Mr. Wicksteed's estimate, would be the additional expense incurred if the supply were doubled and the additional quantities were raised by pumping 150 feet high?—On Mr. Wicksteed's experience the expense would be 25l. 10s. per diem, or 9300l. per annum, which, as about 200,000 houses are supplied by the Companies, when divided gives 11d. per house per annum for the expense of the pumping to a height of 100 feet, or 16½d. for pumping to a height of 150 feet. I wish it, however, to be understood that I do not concur in Mr. Wicksteed's mode of estimating the cost. It is quite true that the expense of pumping forms, in nearly all cases, but a small portion of the total charge to the tenant; but Mr. Wicksteed's statement would afford a result fallaciously low. Mr. Wicksteed's engine uses less coal, but employs more capital, so that the saving is rather apparent than real. And again, the London and many other Companies would be unable to obtain a supply of fuel at the price assigned by Mr. Wicksteed.

In respect to the apprehension expressed, that if the system of constant supply at high pressure were adopted much large mains would be required, what is the evidence of fact and ex

perience?—Directly the reverse of the hypothesis. If the supply of water for ordinary purposes be the only consideration, then, for the same reason that smaller pipes do suffice for the tenants' communication-pipes, smaller mains will suffice for the system of constant supply at high pressure. Where 20-inch mains are used on the system of periodical supply, 12-inch mains would amply suffice for the system of constant supply; instead of the 7 and 6-inch mains, 5 or 4-inch would suffice; instead of 3-inch service-pipes for the occasional supply, 2-inch would suffice for the constant supply; indeed, for constant conveyance, sizes much smaller than these would answer the purpose; but as there are irregularities of draught, it is needful to provide accordingly. The objection of Mr. Wicksteed is founded upon a supposed state of things which never does occur, namely, of all the pipes discharging water at the same time.

An objection to the introduction of water into the houses of the poorest classes is thus stated by Mr. Wicksteed:—"Where a landlord has got 20 or 30, or 40 or 50 houses, and requires a supply of water, if they are poor houses it is frequently given by one common stand-cock to all the houses. If he was to put a separate supply to those houses by a lead-pipe, the lead-pipe would be there in the evening but would be gone in the morning." Now, do you find that tenants are apt, for the sake of the lead, to cut off their own supplies of water; and what, under all circumstances, is your experience on the point?—We have some of the poorest and worst-conditioned people in Nottingham, and we scarcely ever experience anything of the kind. In fact, the water at high pressure serves as a police on the pipe. The cutting off a cock with the water at high pressure is rather a difficult matter to do quietly: "knocking up" is too noisy; and when a knife is put into such a pipe, and a slit is made, a sharp, flat, wide stream issues, very inconvenient to the operator; and when the pipe is divided there is the full rush of the jet to denounce the thief. We have lead-pipes all over the town, in the most exposed places, and I can affirm that such an event rarely occurs *out* of the houses, and never *within*.

At what charge is water given into the houses of the labouring-classes on the system of constant supply and high pressure at Nottingham?—For a two or three story-house of three rooms, the charge being on the rental, it comes to about 1d. per week. For this sum the tenants have any quantity of water they choose to take. The Table of Rates is given in my return to your printed queries.

The two and three story houses are inhabited by the labouring classes, are they not?—They are.

How many of them are supplied in Nottingham at this rate of 1d. per week?—Rather more than 5000 supplied by the

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Trent Waterworks Company have been charged by owners 1*d.* per week in the shape of additional rent.

And this 1*d.* a-week gives the Company its fair interest and remuneration?—The Company's rates vary according to the sizes of the houses, or rather according to the rents charged for them. The annual sum taken in respect of the supply of water to these 5000 houses affords an average of 4*s.* 7½*d.* each.

You give this supply of filtered water (in round numbers) at 1*d.* per week: you having only two-thirds the supply of the town on which to charge the expense of your whole fixed capital, and being able, if you had the supply of the whole town, to pump water for the whole at an addition of not more than one-twentieth to your annual expenses of management?—Yes; but that is the additional expense of pumping only. We should have some additional charges to pay, but those charges would be considerably less than in the proportion of the additional business done.

What has been the effect produced on their habits by the introduction of water into the houses of the labouring classes?—At Nottingham, the increase of personal cleanliness was at first very marked indeed; it was obvious in the streets. The medical men reported that the increase of cleanliness was very great in the houses, and that there was less disease. There was, also, an advantage in the removal of the assemblages round the public pumps. At Newcastle-on-Tyne, where they have common fountains, and where young girls are brought into contact with every description of characters, the effect is highly objectionable.

When, on the return home of the labourers' family, old or young, tired perhaps with the day's labour, the water has to be fetched from a distance out of doors in cold or in wet, in frost or in snow, is it not well known to those acquainted with the labourers' habits that the use of clean water, and the advantage of washing and cleanliness, will be foregone to avoid the annoyance of having to fetch the water?—Yes; that is a general and notorious fact. When the distance to be traversed is comparatively trifling, it still operates against the free use of water.

Before water was laid on in the houses at Nottingham, were the labouring-classes accustomed to purchase water?—Before the supply was laid on in the houses water was sold chiefly to the labouring-classes by carriers at the rate of one farthing a bucket; and if the water had to be carried any distance up a court a halfpenny a bucket was, in some instances, charged. In general it was sold at about three gallons for a farthing. But the Company now delivers to all the town 76,000 gallons for 1*l.*; in other words, carries into every house 79 gallons for a farthing; and delivers water night and day, at every instant of

time that it is wanted, at a charge 26 times less than the old delivery by hand.

An opinion has been expressed, that the most economical mode of supplying the poorer districts is by stand-pipes for the common use of a court or small street. On the other hand, judging from the experience of the general use of stand-pipes in winter, when the tenants' communication-pipes are frozen, taking the point of economy to the parties supplying, and omitting all consideration of the comfort, the inducements to cleanliness, the moral advantages and pecuniary economy to the parties supplied, it is stated that there is what is called a great waste of water. Estimating the tenants' economy, and as stated upon experience the quantity of water required to be fetched, is at the rate of seven gallons per head per house, what might be the value of the labour of fetching water, supposing 10 minutes expended in each journey?—In all probability there would be not fewer than three journeys per diem: and estimating the mean value of the labour of the males, females, and children of a workman's family at 1*d.* per hour, the cost in time would be 3*d.* per week.

That is for seven gallons a-head?—That quantity is, I presume, recited from some other evidence, but the quantity delivered to the working classes at Nottingham is probably greater than that. I have supposed the water to be free of expense, but at Newcastle-on-Tyne the water delivered at most of the fountains is charged for.

You have stated that at Nottingham the charge was a farthing for three gallons sold, and that the amount wanted for a labourer's family would exceed three gallons, even in their insufficient mode of supply?—Yes, but that was with reference to the delivery by water-carts.

Supposing it to be delivered by water-carts, the charge would be a halfpenny a-day for a labourer's family?—Supposing the labourer's family to require 40 gallons a-day, which probably would not be very far from the actual consumption, then at one farthing for three gallons it would be about 3½*d.* per diem.

That is for 40 gallons, which you suppose to be the average consumption of a labourer's family?—Yes.

You have observed that at Newcastle the congregation of persons requiring water was very great, and that much inconvenience was experienced from that?—I have.

You say that is an objection to any stand-cock system?—It is, particularly with an occasional supply.

The introduction of water into the house, and especially on the system of constant supply being then an economy of existing charges, even to the lowest and poorest classes, there appears to be no ground for exempting them (at the expense of others)

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from the payment of their proportion of contribution necessary to obtain the benefit?—Certainly not. The effect of exemption would be not to benefit the *poorest* classes but the owners of the worst conditioned tenements, who, it is well known, obtain rents higher in proportion to the tenant's exemptions. There is no charity in affording a gratuitous supply of water to the labouring classes, for it has simply the effect of making the landlord's tenement more valuable, and he puts that additional value into his pocket in the shape of rent.

You are clear, then, that this constant supply of water, at high pressure, introduced into the houses of the labouring classes, at a penny a-week, is a supply at a fair remunerative profit, and not on any objectionable system of charitable reduction?—This price is remunerative, though in certain instances probably somewhat less so than supplies to larger houses. The small houses are commonly supplied in groups through the medium of the landlords. If the variable cost of pumping be apportioned according to the consumption of water by each separate consumer on the books, considering the owner of a group as one consumer, and the constant expenses of collecting, management, &c., be equally divided amongst the consumers, on the principle of the penny postage, then I think it will appear that the small houses pay a rate fully proportionate to the large ones. I have a strong objection to supply the poor in respect of their dwellings with any article at a lower rate than that at which it is supplied to their more wealthy neighbours; for the difference passes in a very direct manner into the pockets of their landlords, who are thereby enabled to let their houses at a higher rent than they could otherwise command. If, for instance, the house I occupy were to be disburthened by Act of Parliament from the rates and taxes with which it is now charged, the owner would immediately obtain a rent higher by, at least, the full amount of the exemptions. It has lately become the fashion to pacify the presumed opposition of the working classes (which is in reality commonly the opposition of the small owners) to proposed local Acts by inserting clauses to exempt them from the operation of rating enactments—a fashion which, while it does not benefit the working classes to the extent of sixpence, has the effect of compelling the non-holders of cottage property to subscribe unjustly to the rental of others the holders of such property. The attention of Parliament, it appears, has not yet been attracted to this abuse.

It has been assumed “that it would be difficult to persuade the poor generally to pay for a supply of water as it is at present given in some neighbourhoods, and it would be equally so to show the proprietors the advantages to themselves of giving a free supply, and receiving remuneration from those

only who are willing to pay." Now what has been your experience in this respect at Nottingham?—All this has been overcome at Nottingham. Landlords and tenants equally require a supply of water, which the Company affords uninterruptedly. When the Company introduced the uninterrupted supply at Nottingham the poorest tenants required it of their landlords; the landlords then said, "If you will consent to pay an additional penny per week of rent, we will try to arrange it with the Company." This was the case in thousands of instances. The charge was in these cases made upon the landlord and he put it upon his rent and the tenants most cheerfully paid it. The Company have found it necessary to decline affording any supply to weekly tenants, because being a very migratory class, they never could collect the water rent from them, they will not therefore supply any weekly tenants but through the landlord.

Does your own experience furnish any datum from which the expense of supplies of water, including the wear and tear of engines, interest on fixed capital for machinery and all distributary pipes, the necessary expenses of management, in other words, the total expenses, may be judged of?—Yes; the total expense is on the experience of the last five years 2·88d. per 1000 gallons. This is equal to 12*l.* per million gallons.

We are desirous of being informed of the several establishment charges of a Water Company, or in other words, what charges are independent of the quantity of water pumped, and what not, and their amount. Can you give us from your practical experience, say at Nottingham, where you lift your water 135 feet high?—On an average of five years' experience of the Trent Company, at Nottingham, they are as follows for each million and for each thousand gallons.

[*The Witness put in a tabular statement, see next page.*]

40 *Statement of the Elements of Cost of supplying Water.*

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TABULAR STATEMENT of the Expenses incurred in supplying the Town of Nottingham with Water, according to the experience of the Trent Water Works Company :—

Description of Charges.	Cost per 1000 Gallons.	Cost per 1,000,000 Gallons.	Total of each Class of Items per 1,000,000 Gallons.	Proportion per Cent. to Total Charge.	Proportion in Money of each Class of Items for each 1000 Gallons.
	d.	£. s. d.	£. s. d.		s. d.
<i>1. Charges nearly proportionate to the Quantity supplied.</i>					
Coals	0·3035	1 5 3½	} 1 12 4½ {	10·5	} 13·5 {
Oil and tallow	0·0480	0 4 0		1·7	
Sundries	0·0137	0 1 1½		·5	
Hemp, leather, &c.	0·0119	0 1 0		·4	
Repairs of pumping machinery .	0·0111	0 0 11		·4	
<i>2. Charges which diminish nearly as the Quantity pumped or supplied increases.</i>					
Salaries of law clerks, engineer, } office clerks, collectors, &c. . . }	0·3720	1 11 0	} {	12·9	} 27·6 {
Parochial and other taxes	0·1328	0 11 0½		4·6	
Wages of turncocks, plumbers, &c.	0·1295	0 10 9½		4·5	
Incidentals attending the ma- } nagement }	0·0461	0 3 10		1·6	
Law charges and expenses of po- } licemen }	0·0366	0 3 0½		1·3	
Rents of various premises, ac- } knowledgments under Act of }	0·0300	0 2 6		1·	
Parliament, &c. }					
Repair and maintenance of mains, } cocks, communication pipes, }	0·0196	0 1 7½		·7	
and other works of distribution }					
Stationery, advertising, &c. . . .	0·0136	0 1 1½		·5	
Compensations for damage, &c. . .	0·0089	0 0 9	} {	·3	
Gratuities, medical assistance, &c.	0·0049	0 0 5		·2	
	0·7940				
<i>3. Charges which diminish less rapidly than the Quantity of Water pumped or supplied increases.</i>					
Wages of engine-man	0·1063	0 8 10½	} {	3·7	} 8·3 {
Wages of stoker and reservoir- } keeper }	0·0650	0 5 5		2·3	
Cleaning and other ordinary } charges of the lower or filtering }	0·0367	0 3 0¾		1·3	
reservoir }					
Repairs of buildings	0·0215	0 1 9½		·7	
Cleaning and other ordinary } charges of the upper or storing }	0·0107	0 0 10¾		·4	
reservoir }					
	0·2402				
Interest on invested capital, vary- } ing directly with extent of }	1·4570	6 1 5	6 1 5	50·6	0 1½
works and inversely with }					
amount of supply }					
Totals	2·8794	..	11 19 11½	100·	0 3 (accurately) 0 2½
The income amounts to 3·17d. per 1000 gallons; the difference (0·29d.) is applied to extension of works.					

But the price of fuel will vary greatly in different places? T. Hawksley,
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—Yes.

And the description of engine will also vary, and so influence the consumption of fuel?—Yes.

Now what descriptions of engines, and prices of fuel, taken in relation to each other, will afford the result shown in your table?—They will stand nearly as follows:—

Description of Engine.	Steam Pressure.	Price of Fuel, Delivered.*
		s. d.
1. H. P.—Double powered, non-condensing }	30 + 0	6 0 per ton.
2. B. and W.—Double powered, condensing }	3½ + atmos.	9 0 „
3. B. and W.—Single powered, condensing }	3½ + atmos.	12 0 „
4. Cornish.—Double powered, condensing† }	30 + atmos.	16 0 „
5. Cornish.—Single powered, condensing† }	30 + atmos.	20 0 „
6. Cornish.—Single powered, condensing† }	45 atmos.	25 0 „
7. Taylor's Cornish.—Single powered, condensing† }	. . .	32 0 „

Then is the relative economy of these engines such that, for instance, the engine No. 6 would perform the same amount of work with 9*s.* worth of fuel, to do which the engine No. 2 would require 25*s.* worth?—Yes; but against this advantage must be placed the vastly greater first cost of the engine No. 6, and its much greater liability to accident. By the use of the Cornish engine No. 6 in place of the Boulton and Watt engine No. 2, a saving of nearly 0·2*d.* per thousand gallons would be effected in the fuel account, but the capital account would be increased fully 0·1*d.*; the resulting economy to set against increased risk would, therefore, not exceed a twenty-ninth part of the whole charge. I should, therefore, be in general disinclined to recommend the adoption of the Cornish engine, except, perhaps, in the case of works of such great extent and so arranged that the public would not be inconvenienced by the stoppage of a single engine.

From the statement it appears that of each thousand gallons which you may sell for 2·88*d.*, or nearly 3*d.*, that the total or general charges, exclusive of the interest of capital, amount to 1·42*d.* (or a little less than 1½*d.*), for this same thousand gallons?—Yes.

And of this 0·79*d.*, or about ¾*d.*, applies to charges for management, salaries, taxes, rents, law charges, and certain items for

* Quality equal to Newcastle coal.

† Expansive action.

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repairs and wages, which would diminish if the quantity pumped were greatly increased?—Yes.

And 0·24*d.*, or about $\frac{1}{4}$ *d.*, applies to charges for attendance on machinery and cleansing the reservoirs, which would be partially diminished by an increase of the quantity of water?—Yes.

Then, in fact, there remains only 0·39*d.*, or less than $\frac{1}{2}$ *d.*, out of nearly 1 $\frac{1}{2}$ *d.*, per thousand gallons, to defray charges such as coals, hemp, leather, oil and tallow, repairs of machinery, &c., which are strictly proportionate to the quantity of water delivered?—Yes.

Besides this, if the quantity of water pumped and supplied to the same tenantry were greatly increased, we take it the interest on the investment might, under a proper system of supervision and protection, be made to press less heavily on a given portion, say 1000 gallons of the quantity of water so increased?—Certainly.

It is stated that in the metropolis the expense of machinery or capital invested is about 3*l.* per individual supplied, (that is to say, for the Company's machinery, and exclusive of the tenants' communication-pipes, the tenants' water butts, tanks, &c.,) or 3,310,342*l.*, on which the income is stated to be 276,243*l.*, and the expenditure 133,724*l.*, yielding, it is stated, an average dividend of 4 per cent. But to the capital account is placed much of the expense of competition, of private Acts, of enlargement and alterations consequent on original errors; and to the expenses of management, the expenses of several sets of officers and supervision of machinery going over the same areas. Now what may be the expense of machinery, reservoirs, pipes, and apparatus per individual supplied at Nottingham, and the proportionate expense of management?—The cost of construction is, at Nottingham, something less than 1*l.* per individual, supplied by the Trent Water Company, but if that Company had the sole supply of the district over which its pipes are laid, the cost would not exceed 15*s.* per individual. The expense attendant on the supply of water and management of the works amounts to about 44 per cent. on the income, which is slightly less than the proportion of the like expense in London.

In the case of supplies on a larger scale than at Nottingham, may not your scale of expenses be still further reduced?—The more numerous the tenants the cheaper can a supply be rendered. I conceive that if the number of tenants now supplied by the Trent Water Company were doubled, the Company would have little more to pay for engineering, law, rates and taxes, wages, &c., than at present, and that an economy of at least 10 per cent. would result on the No. 2 items alone.

May this scale be taken as the fair rate for estimating the expense of taking improved supplies of water for 70,000 houses, to which it would appear, from the census return and the Companies' return there has yet been no regular or adequate supplies of water given?—This is uncertain. The cost will depend upon the compactness of the buildings to be supplied, and the proximity of the source whence the water is derived. If the 70,000 houses lay near together, and water were obtained within one or two miles, 1*l.* per individual would probably suffice. If the houses be far apart, the streets wide, and the water remote, more than 1*l.* per individual might be required. Under certain circumstances it becomes more economical to supply from two works than from one, but it is rarely desirable to do this under two distinct managements, and it is always injudicious as regards economy to introduce the works of two Companies into one district; so much so, indeed, that the loss or useless expenditure may generally be estimated at from two-thirds to three-fourths of the entire capital of the smaller Company, in addition to the amount of the unnecessarily increased working expenses.

If at the scale of the actual expenditure for Nottingham, the 200,000 houses of the metropolis now only supplied with water by the several companies periodically were to be supplied by a public agency *de novo*, what would be the actual amount of capital required, and the annual income?—I cannot afford a very satisfactory reply to this question, from want of due information as to the distance from which the water would be brought. But supposing the metropolis could be divided into districts, each of 30,000 or 40,000 houses, the water might perhaps be delivered to the several inhabitants on an investment of about 8*l.* per house, supposing the water to be conveyed to engines in the neighbourhood; the cost incurred in works for conducting the water from a distance would be additional, and would probably amount to at least 2*l.* more. The income of the Trent Water Company being 1*s.* 6*d.* per individual supplied, the annual income derivable from 1,200,000 individuals, residing in 200,000 houses, would be 90,000*l.*; which, with the charges for supplies to baths, inns, water-closets, roads, manufactories, &c., might be increased to about 150,000*l.* Now, since it usually happens that the income of a Water Company must be one-tenth of the investment to pay dividends of 5 per cent., it is plain that 1*s.* 6*d.* per individual would not be a sufficient charge in the metropolis. I believe, however, that 2*s.* 6*d.* per individual would be ample. It is, however, fair to state that all the Water Companies have incurred large expenses in effecting alterations and improvements to meet the wants and wishes of a city rapidly increasing in magnitude and improving in

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habits, and therefore from time to time in need of more abundant supplies of improved quality.

Now if the cost of 1000 gallons of water be $2\cdot88d.$ on the scale of supply at Nottingham, what do you suppose it would be on the system of constant delivery in a larger town where the consumption would amount to five million gallons per diem?—The charges, exclusive of interest on capital, would be reduced from $1\cdot42d.$ per 1000 gallons, to about $0\cdot94d.$ per 1000 gallons; the whole cost would therefore probably be reduced from $2\cdot88d.$ to $2\cdot40d.$, or about 17 per cent.

And what would be the reduction if the extent of supply amounted to 40 million gallons per diem, as appears to be the case in the metropolis?—The charges, exclusive of interest on capital, would be about $0\cdot80d.$ per thousand gallons, and the total cost about $2\cdot26d.$, or two-pence farthing per 1000 gallons.

And what would be the whole expense at $1l.$, $2l.$, and $3l.$, per individual for capital?— $2\cdot26d.$, $3\cdot72d.$, and $5\cdot18d.$; or in round numbers, $2\frac{1}{4}d.$, $3\frac{3}{4}d.$, and $5\frac{1}{4}d.$ per thousand gallons.

How much would this amount to per annum?— $137,500l.$, $226,300l.$, and $315,100l.$

And what would be the additional annual cost of artificial filtration?—About $20,000l.$

Then allowing for this, it seems that about $40,000l.$ per annum is the loss in the metropolis alone, by want of consolidation and supervision, exclusive of a large amount of interest on the capital uselessly employed in competition?—That is very likely.

You have stated that, on the system of constant supply at high pressure, smaller instead of larger mains would suffice. It has been stated that at one town, where a high pressure was put on old mains and distributary pipes constructed for a low pressure, the pipes which burst were very few, and the inconvenience (which it was anticipated would be very great) was inconsiderable. Does your practical experience enable you to express a confident opinion that the mains and ordinary distributary pipes for the system of periodical supply would not be required to be extensively superseded, and others of greater thickness substituted for the application of a system of constant supply, under a system of moderate high pressure, such as that contemplated?—Yes; the amount of pressure does not practically enter into the determination of the thickness of the metal of main pipes. Any thickness at which mains can in the regular course of foundry business be cast will afford many times the strength requisite to retain water under a pressure of 150 feet. In fact, pipes are proportioned according to the difficulty of running the metal and adjusting the core; and, in practice, it is customary to prescribe a thick-

ness of, at most, one-fifth the square root of the diameter ($\cdot 18 \sqrt{d}$), a proportion which has no reference whatever to the strain arising from the pressure. Pipes are now cast lighter than formerly, although the pressure under which water was usually transmitted has been increased.

Be so good as to explain the method by which you ascertain the dimensions of pipes for a constant supply to the attic stories?—Assuming the case of a street of houses 600 yards long, I proceed thus:—I first ascertain, perhaps, by the parish books, the numbers and rentals of the houses; I then estimate the consumption of water in each house in gallons at $12\frac{3}{2} \sqrt{\text{rent in pounds}}$, which I find by experience to afford a result as accurate as the nature of the inquiry will permit.

This gives for houses of 6*l.* rent 40 gallons per diem.

„	„	10 <i>l.</i> rent	56	„
„	„	20 <i>l.</i> rent	88	„
„	„	50 <i>l.</i> rent	163	„
„	„	100 <i>l.</i> rent	260	„
„	„	200 <i>l.</i> rent	410	„
„	„	500 <i>l.</i> rent	756	„

To obtain a proper practical taper, I divide the length of the pipe into portions of about 200 yards, and assign to each the quantity of water to be conveyed; thus

Final 200 yards	. . . . .	13,000 gallons per diem.
Middle 200 yards	11,000 + 13,000 =	24,000 „
First 200 yards	8,000 + 24,000 =	32,000 „

I next consider that nearly the whole of the water will be consumed in the four or five hours elapsing between breakfast and dinner: to err on the safe side, I assume the delivery to take place in four hours, and that the whole of the water taken off from each length has to be passed to the end of that length. It will sometimes happen that the reservoir from which the supply is obtained is nearly on the level of the attic stories, and that in consequence perhaps not more than four feet of head can be allowed on each length of 200 yards to produce the velocity and overcome the friction: allowing this quantity in the case assumed, I shall be enabled to apply the formula,

$$\frac{1}{15} \sqrt[5]{\frac{q^2 l}{h}} = d,$$

which I have found to apply with great exactness: in this formula (*q*) represents the number of gallons to be delivered per hour, (*l*) the length of the pipe in yards, (*h*) the head in feet, and (*d*) the diameter of the pipe in inches.

We now obtain the following diameters:—

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First 200 yards . $5\frac{2}{16}$ inches ;

Second ditto. . $4\frac{5}{16}$ inches ;

Third ditto . $3\frac{6}{16}$ inches ;

to which, adding half an inch for possible contraction by corrosion, the practical diameters become six inches, five inches, and four inches for a street, producing in London a water rental of at least 300%.

What would be the saving in the size of the pipes consequent on the system of constant supply as compared with the intermittent system?—The diameters of the service-pipes and sub-mains are diminished about one-third, and the weights of the pipes about one-half.

The saving in the size of the service-pipes, the mains, and so forth, would compensate for the cost of throwing up by engines an additional quantity of water to meet the apprehended waste and additional consumption, and keeping it constantly on?—Yes; and the management is much more easy, and the number of men necessary to superintend the distribution of the water becomes much fewer,—in fact, it demands very little attention indeed, where the water is constantly running through the pipes; but where the water is given at intervals, many persons are put to great inconvenience; then they are complaining, and must be attended to; and the ball-cocks when they go down will stick very frequently, and there is, consequently, a great waste of water, so that a great quantity of water is not well applied. The waste is very great on the intermittent supply, much more, I am satisfied, than most engineers are aware of. We have found, in many instances, where our supply has been turned off a particular street for a short time, the ball-cock of a cistern has gone down, and the water run to waste after being again turned on. That happens in all towns where the supply is intermittent; and I believe the waste from this and some other causes is much greater than that which occurs in a constant supply.

In stating generally your view that the supply of a town by the medium of a constant supply and high pressure is quite as cheap or cheaper than under the other system of an intermittent supply, do you take into consideration that, in the one case of constant supply and high pressure, there would be greater advantage to the people and a greater supply of water?—I did not take that into consideration in the first instance; but I think the saving in the number of officers and in other respects would more than compensate for the cost of pumping that quantity of water; for the mere cost of raising the water is but a trifling portion of the expenses of a Water Company: a great many expenses are permanent standing expenses; the greater proportion are in a great degree independent of the quantity of water lifted.

You think that, for 4s. 4d. a house, you can give the constant supply of water which is required for the use of a cottager's family?—We do that.

Do you think you can give it at 4s. 4d. constantly, when under one plan it would cost the Company that to do it only periodically?—Certainly; we have tried the experiment for a month, and we found that, although there was an economy to a certain extent, insofar as the supply of water went, the cost of attendance, irrespective of the inconvenience to the people supplied, was far more than would compensate for that trifling advantage.

You say that the arrangement, generally speaking, in Nottingham between the landlords and tenants, is that they should pay 1d. a-week,—is that the amount of the Water Company's charge to the landlord, or do the landlords make any profit out of that?—I think I had better explain that the Water Company obtains from the landlord an account of the rent of each house, and takes 1s. in the pound of the rent, and allows the landlord a discount of 25 per cent. (which reduces it to 9d. in the pound on the rent) to cover any incidental losses he may sustain. Supposing a house were let at 6l. a-year, or 2s. 4d. a-week, the Company's first charge would be 6s. a-year; but then the landlord would receive back again an allowance of 1s. 6d., which would reduce the charge to 4s. 6d., and, practically, the landlord would increase his rent 1d. per week; so that, probably, by that arrangement he might lose by each tenant 2d. in the year.

What is the expense of carrying the pipe into each house on the average?—If the house abutted on the street, the tenant's cost would probably not be above 4s. or 5s.

In the case of taking it up a court it may amount to more?—Yes; in some cases probably to 50s. or 60s.; there it would give water to 10 or 12 houses probably.

Dividing that, according to your practical knowledge, to what does it generally amount per house?—Not more than 4s. or 5s. in either case.

Then there is an addition to the charge paid annually, also a charge of 5s. to take it in; is that done in any cases by the Company?—No, it is not; and one of the principal reasons is this: in a town where there are already two Companies, both having their pipes extending over the same distance, and both being in competition, it is of course a matter of some importance not to disoblige the plumbers; therefore the Company say, "We will lay all the pipes which are our property ourselves, but we will not interfere with the plumbers;" indeed, such interference would make a material difference to the credit of an unprotected Water Company.

Taking a town, would it not be a convenient and cheap

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arrangement for the Company to have their own workmen to lay down the tenants' communication pipes?—Probably there would be a great saving of expense. The Gas Companies—the Liverpool Gas Company, for instance—prescribe that their own workmen shall lay the pipes, and they do that not only to prevent frauds by the tenant, but to secure themselves against escapes of gas.

Would it not be an advantage that the Company should be able to do the whole, and spread it over several years instead of having it paid in one sum, which prevents its being done in some instances?—It would be a great advantage, but in the present state of the law that could not be practically effected, and it would be impossible to carry it out in towns where, as in Nottingham, there is the general disadvantage of competition, because the owner of the property or the tenant could move his pipe to the other Company immediately, and we should lose the advantage of the annual charge.

Supposing you were beginning to supply a town where there was no supply already, would not such an arrangement be a good one for both parties?—Undoubtedly, if the interest of the Companies could be secured by having some central supervision over them; but they would be quite at the mercy of the inhabitants unless that were the case. Other Companies might be introduced, and they might then lose their whole expenditure.

This Company with which you are connected supplies very efficiently and at a very low rate of remuneration; what dividend does it pay?—It pays six per cent. on the amount of the shares raised by Act of Parliament. For a period of four or five years it received no dividend at all, but applied the profits then made to the extension of the works, and therefore the dividend it receives may be considered as applied to the whole outlay, consequently it would be fair to consider the six per cent. taken on the partial outlay as equivalent to about five per cent. on the total outlay.

Under the existing circumstances at the prices charged and the benefit conferred, do the Company divide actually five per cent. upon the outlay?—Yes, and the 50*l.* shares of the Company sell at from 70*l.* to 73*l.* each, and have done so for some years. The dividends of the Company are 3*l.* on each 50*l.* share, and that is considered in the transfer of shares to represent a value of 70*l.*

In the application of the constant pressure system to the better classes of houses, would you think it desirable at once to make such a change in the present system as to do away with it entirely?—Yes, I think so; I see no difficulty in the way; there might at first be some additional waste, because the lead communication-pipes are now in some cases very

imperfect, and there is not due attention paid to them, because the Water Companies know that the waste is not so great when the water is only on a very short period as it would be if kept on constantly; but it would very soon find its own remedy. We pay great attention to this; the attention paid is not expensive, and the consequence is, that we are able to keep the water on constantly, without great loss to the Company, and with material benefit to the town at large.

Apprehensions have been expressed that under a system of constant supply there would be required to be a system of constant visitation of the premises, and a system of constant inspection by the officers of the Company, to which the inhabitants would not readily submit. Now as to the fact under the system of constant supply, is any increased visitation or inspection of the premises found to be requisite?—There is much less necessity for visitation when the system of constant supply prevails than in cases where the supply is intermittent, and there is less risk of the water being suffered to run to waste through negligence. At Nottingham there have been very few inspections, and those chiefly in consequence of the rivalry between the Companies, which has been productive of much confusion of pipes and uncertainty as to the source of the supply.

Do you conceive that the high pressure could be engrafted on the present system in London without a very material difficulty in point of expense?—I think it might, particularly if the supply were constant. I think there would be no difficulty in the arrangement, but there would be some expense for large vertical pipes or towers into which to pump, or reservoirs at some elevated points, those of course would be almost necessary, one or the other; but that is a question of expense entirely, and not of practicability.

Would it involve an alteration of the mains?—That would depend upon whether the water could be conveyed into upper reservoirs or would be pumped into stand-pipes, or be raised under the pressure of an escape-valve; but this last mode is very undesirable. If pumped into stand-pipes, there would be little alteration of the mains; but if pumped into reservoirs, there must be considerable alteration.

That is the case at Nottingham?—Yes, and also at Newcastle-on-Tyne.

They pump it there into a reservoir before it comes into the main, do they not?—No; the branches which supply the town are taken off the main pipe. I think there are three. There is no returning branch immediately out of the reservoir; the main pipe itself is the returning pipe.

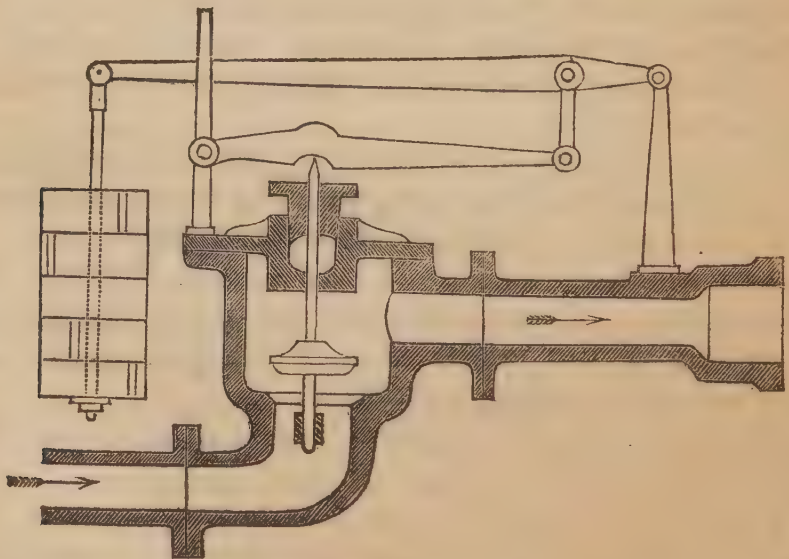
From your experience and judgment, would you be going to undertake the supply of a town?

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recommend the high pressure as the cheapest, on the whole, to the inhabitants, to give them an adequate supply?—Much cheaper to the inhabitants, and very little additional expense to the Company. I am not quite clear, indeed, that it would be any additional expense to the Company; for though it might in some instances, necessitate a greater annual outlay, it would effect some saving in the investment, as the pipes would not necessarily be laid of a somewhat smaller size than would be required for the purpose of giving an intermittent supply.

Taking into consideration that you must calculate, in an Company, the profit to be made—and taking into consideration all circumstances—should you recommend the high pressure as that which would give a supply at a cheap rate, and afford at the same time a reasonable profit to the proprietors?—Yes, and I consider that as the ordinary mode in which the Companies should effect their supply. At Nottingham we never speak of high pressure.

If a city were situate near a very high elevation, on which it would be convenient to place the reservoir, say 300 feet, giving a greater pressure for the tenants' communication pipes in the lower districts than is requisite for the various purposes of a constant supply, at high pressure, have you any plan of meeting such cases, or modifying such pressure?—In such case I should endeavour to bring the leading main from the higher part of the city to the lower, lay off the sub-mains and service by lines of equal altitude, and reduce the pressure at proper decrements of height by a loaded valve, as shown by the sketch.



Under the system of constant supply at high pressure have you, on the occurrence of severe frosts, experienced any peculiar inconveniences; and have the tenants experienced such?—The present arrangements of the stand-pipe are very imperfect; there is much unnecessary exposure

of them, which, under the circumstances of rivalry and competition, cannot be obviated. These pipes, therefore, sometimes sustain injury from the frost. The expense of repair is, however, inconsiderable. The pipes laid in earth or within the houses rarely receive any injury.

What do you deem the practicable arrangements by which they might be better protected?—By enclosing them in boxes, and surrounding them with non-conducting materials, such as sawdust, tan, charcoal, felt, flannel rags, straw, &c. And to obviate the effects of the most severe frosts a stop-cock to turn off the water, and a discharging-cock to empty the pipe, may be used. This arrangement is occasionally used for the protection of the feeding-pipes of water-closets where they extend to considerable distances and are carried into exposed situations. The better mode is rather to protect the pipes by surrounding them with non-conducting substances of a sufficient thickness than by emptying them; attention to which is occasionally neglected. The tenants also protect the pipes by allowing a small stream of water to run from the tap. This is effectual, but occasions waste. During the most severe frosts the supply is cut off by congelation in only very few instances.

It is stated that gas at some times gets into the water-pipes laid on the system of the intermittent supply, is this ever the fact?—Occasionally it is so.

How does this arise?—It occasionally happens that the gas-pipes leak; it occasionally happens, also, that the water-pipes leak. If the defects occur near each other, and the water be turned off, a partial vacuum may be created in the water-pipe by the withdrawal of the water, and the gas be drawn in through the aperture. Instances of this kind have occurred in many places, and have been productive of unpleasant consequences. Several times, to the surprise of the parties, the water-taps have taken fire, and several serious explosions in dwelling-houses have been, undoubtedly, traced to this cause.

It is stated by the director of a Water Company that gas sometimes gets into the water-pipes in the metropolis, and taints the water, would not such occurrences be prevented by the system of constant supply?—Entirely.

Do you conceive that the mode of clearing water on a large scale in reservoirs, generally by subsidence, admits of improvement by the substitution or addition of any system of filtration?—Yes; it is always advantageous to filter water which is not naturally bright, to clear it from matters held in suspension. If the extent and thickness of the filtering-bed be very considerable, prior subsidence may be altogether dispensed with; but if the surface be limited, and the thickness

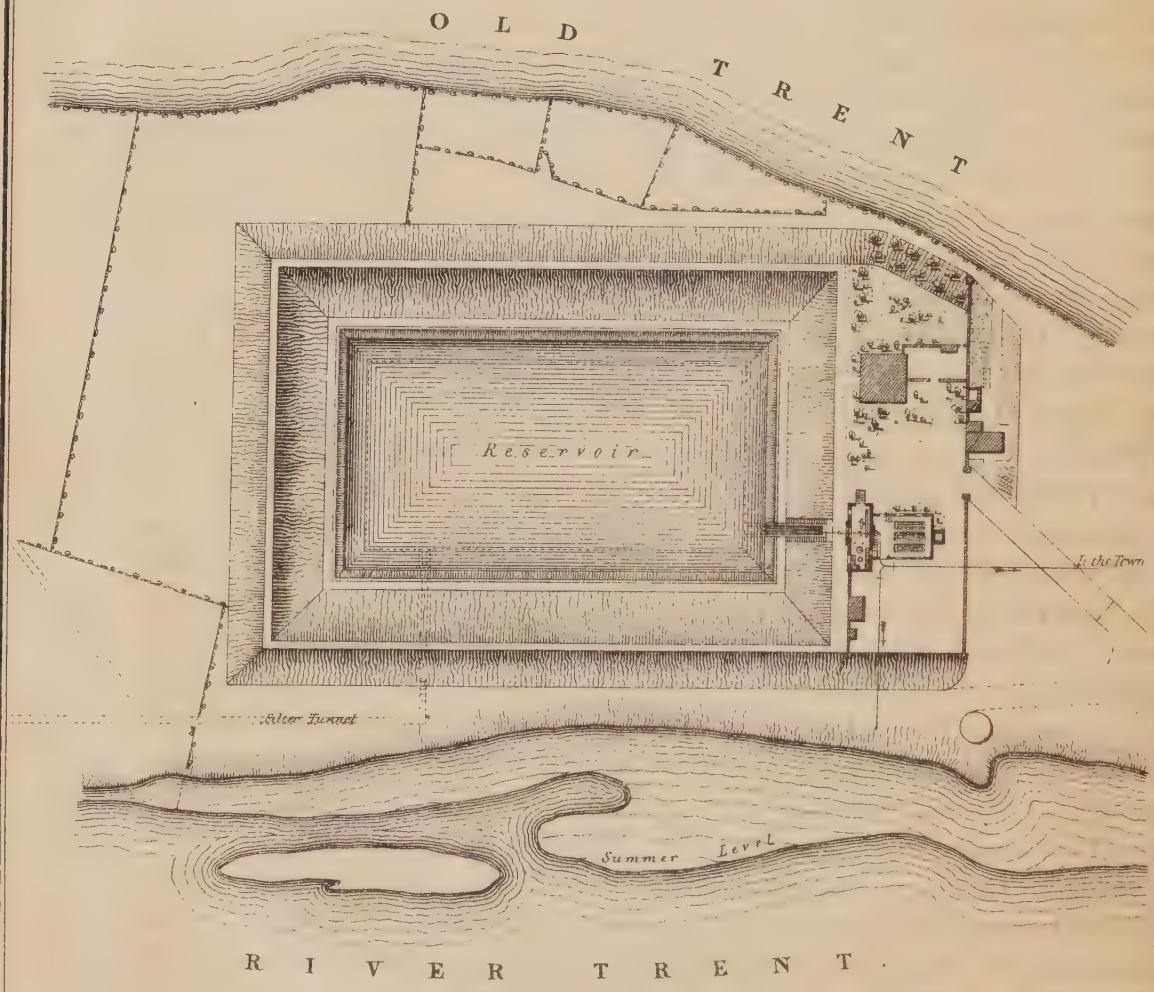
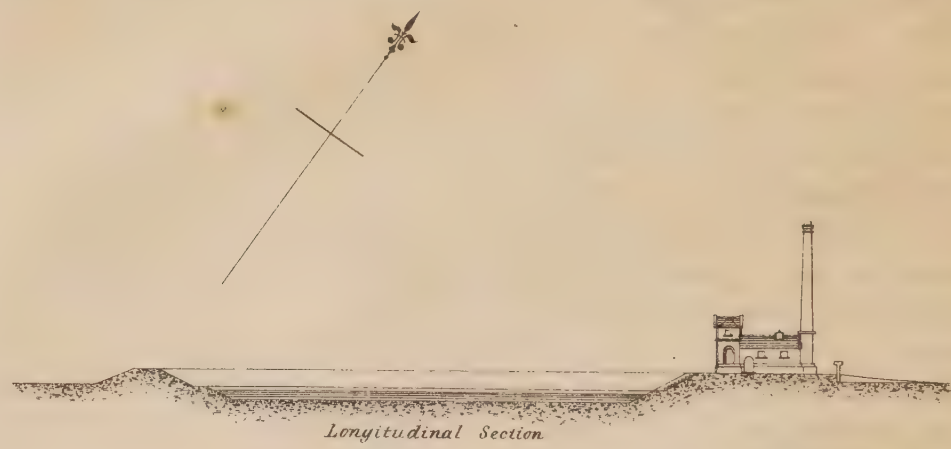
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small in respect to the quantity of water to be treated, as is usually the case when artificial filters are employed, then it becomes necessary to resort to previous subsidence. There are particles so fine and minute as to be incapable of being deposited by the force of gravity, though they may be detained by filters, if the operation be slowly and cautiously conducted. At Nottingham, the construction of the filter is this: the reservoir which lies on the banks of the Trent, about a mile from the town, is excavated in a natural stratum of clean sand and gravel, through which the water slowly percolates to a distance of 150 feet from the river. The adventitious solid matter is gently deposited on the bed of the river, from which it is washed away by the action of the stream. Sometimes the water comes down the river exceedingly thick, and discoloured by peat and other vegetable matters; it is sometimes of the colour of tea: nevertheless filtration through the bed of 150 feet renders the water perfectly pellucid. When the bottom of the reservoir has been bright from a recent sweeping, I have seen a pin at the depth of eight or nine feet. The reservoir being exposed to the action of the sun produces vegetation of the conferva genus, which is removed at short intervals of about three weeks each in summer and of about six weeks in winter, by pumping out the water and the use of the broom. To prevent the small communication-pipes from being choked by the accidental introduction of leaves and other extraneous substances, the water is drawn through large sieves of fine strainer cloth. In addition to the reservoir there is a filter-tunnel passing through a similar stratum for a considerable distance up the adjoining lands. This tunnel is four feet in diameter, and half-brick thick, and being laid without mortar or cement, cost only 10s. a-foot, including excavation to a depth of 12 feet.

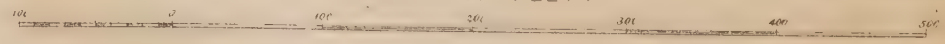
What are the relative advantages of the tunnel and the reservoir?—The office of the reservoir, in addition to the filtration through the bank, is to receive and accumulate the water during the time the engine is not at work. The tunnel is formed simply for the purpose of filtration. The tunnel has the advantage of not exposing the water to the action of the sun.

How is the water transmitted to the upper reservoir?—It is forced by an engine along a main-pipe, which passes through the middle of the town and supplies all the inferior pipes in its course. The upper reservoir, placed at the extremity of this pipe, receives the excess of water pumped by the engine, and returns it down the same pipe so soon as the engine ceases to act, and hence a constant supply is maintained without difficulty, trouble, or expense.





SCALE OF FEET.



Is it not a general practice to pump directly from the river? —Yes; but there are some variations from this practice. At some works the water is allowed to deposit the grosser matters by subsidence either prior to or after being pumped. At others, as for instance at Chelsea and Newcastle-upon-Tyne, artificial filtration is resorted to; but in these cases the filter-bed is thin, its extent limited, and the percolation therefore rapid.

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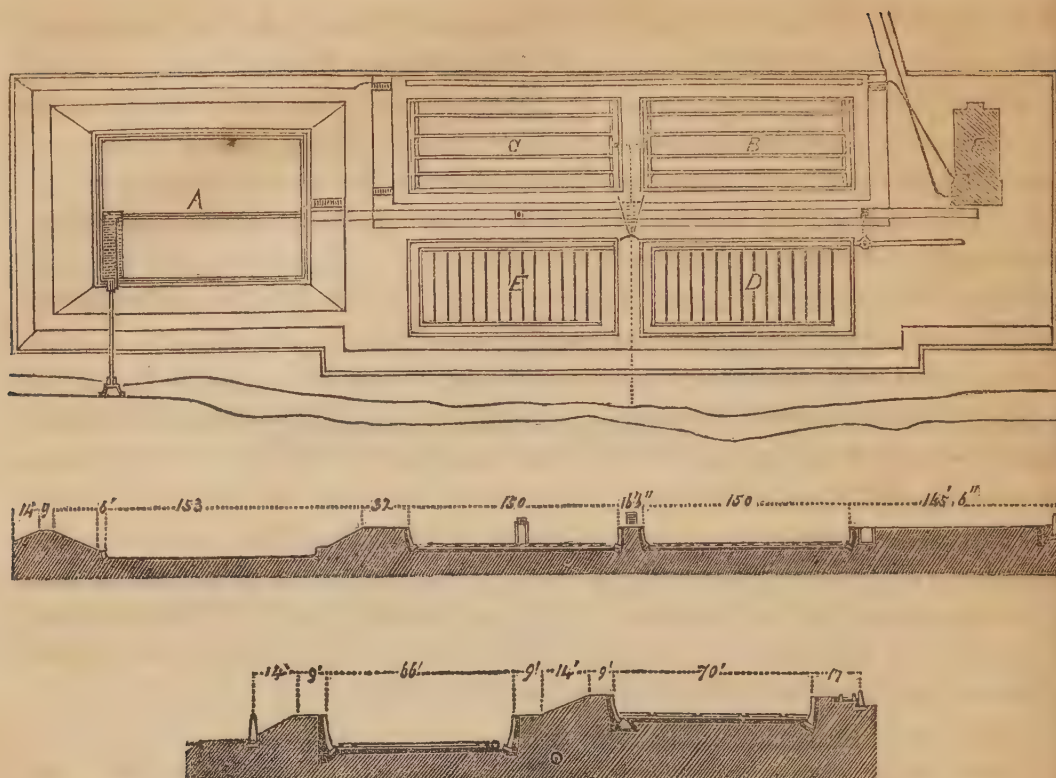
Where a river passes through clay it is presumed that an artificial filtration must be used?—Yes.

Do you believe that your mode of filtration might be made available in many instances, and for future purposes, with advantage to the public?—Undoubtedly; there are many rivers with natural beds of sand and gravel in their vicinity.

The case you have provided for at Nottingham, for the filtration of the supplies of a town, appears to be the case where there is, in communication with the river, a permeable stratum convenient for the operation. Have you been called upon to advise on the formation of an artificial filter on the banks of a river where there is only clay or impermeable strata?—Yes, I was called upon by the Old Water-works Company at Newcastle-upon-Tyne, to design an entirely new set of works for them. The bank of the river upon which the works were proposed to be placed is a stratum of clay of considerable thickness, and the water is at times brackish.

Will you favour the Commission with the plan which you have prepared for that purpose?—The plan proposed, was in general terms as follows. A capacious reservoir (A) was to be formed in the clay below the level of low water; into this reservoir the water was to be rapidly admitted from the river, probably in 15 or 20 minutes, at that period of the tide in which it was in its best and purest state. This would commonly be a little before or a little after the time of low water. From this reservoir, after depositing the heavier particles, the water was to be raised by a steam engine (F), alternately into one of two subsiding tanks (B C), in which tank finer particles of matter held in suspension would be gradually deposited. From this subsiding tank the water would gradually flow upon one of two filter beds (D E), after passing through the materials of which it would be elevated into a reservoir at the head of the town, by means of the same steam-engine by which it was raised into the subsiding tank, and by the same stroke by which other water was being raised into the other subsiding tank. The subsiding tanks and the filter beds were to be constructed in duplicate, that one pair might alternately be cleaned, whilst the other pair were in active operation. The reservoir (A) to receive the water and deposit grosser particles admitted of being cleaned by the pump of the engine, and did not require to be formed in duplicate.

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Were there any other arrangements peculiar to any part of this apparatus?—Yes, the upper reservoir to this proposed construction of water work, was to be formed thus:—Below the bottom, a dry brick tunnel was to be formed, surrounded by strata of gravel and sand through which the water would percolate in its passage to the main pipe from which the town was to be supplied. By this means the water would become entirely freed from insects, plants, which are generated in all open reservoirs, leaves, and other extraneous matters. Some of the confervæ grow with extraordinary rapidity. I have known a growth of many feet to occur in a single day; plants of this character are also liable to very rapid decomposition, and therefore should be very speedily removed.

But if the first filters act properly, why is it that a further process should be needful?—The rays of light penetrate so easily, even through a considerable depth of well-filtered water, that under their agency plants of the kind mentioned are produced at the bottom with much greater rapidity than when the water is less transparent. It, therefore, becomes proper to make some additional provision by which these subsequent productions may be detained, as well as any insects which may be generated or find their way into the water. The production of vegetable matter is almost invariably accompanied or immediately succeeded by the appearance of animalcules.

Would it not be a more advantageous construction to have the reservoirs so made as to exclude the rays of the sun?—To a certain extent it might, but the expense of effecting

that object would frequently be enormous, and in general quite disproportionate to any advantage gained.

How was it that the plan you proposed was not carried into execution?—When it was about to be carried into execution, the two companies entered into an arrangement under which the then new company became the purchaser of the existing works and interests of the old company.

The whole works then became the works of the new company, and they had the uncontrolled right of supply?—Yes, they had.

What would have been the expense of executing the proposed work of filtration?—The estimate for the completion of these works, including the large main, to communicate between the lower and upper reservoirs, was 17,000*l.* or 18,000*l.*

What was the capability of this work?—On the system of constant supply, it would have been adequate for a population of 40,000 or 50,000 people.

That is to say about 10,000 houses?—Yes.

How much of this expenditure would have been for the works of reservoirs of subsidence and filtration?—Not so much as one-half.

Then that would be nearly 1*l.* per house expenditure for filtration?—Less than 1*l.* per house; in general, not exceeding 12*s.* or 15*s.*

This would be for the fixed capital employed in construction. What would be the extra expense of the management to effect the filtration process?—In general, about one-third of a penny per 1000 gallons, subject of course to local variations according to the difficulty and expense of procuring sand, and in proportion to the extent with which the water might happen to be charged with sedimentary matter. In one work the expense of the filtration amounts to one halfpenny per 1000 gallons; in another to one-third of a penny; and in a third, the Southwark Water Company, to one-sixth of a penny per 1000 gallons, which, for the supply to a labourer's tenement, assuming it to be 40 gallons per diem, would amount to about 4½*d.* per annum, or one-third of a farthing per week.

That is to say, at 5 per cent. interest on the fixed capital, making altogether 8*d.* or 9*d.* interest, and 4½*d.* management, little more than 1*s.* per annum, or less than one farthing weekly extra, for ensuring the purity, by filtration, of a supply of 40 gallons per diem, for beverage, for culinary purposes, for washing, for baths, where there are conveniences, and for all other purposes?—Yes.

You have stated, in respect to what may be termed the natural filtration, or percolation through a natural stratum, such as the one in use at Nottingham; that the clearness

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produced in the water is such, that when the bottom of the filter is swept and clean, you have seen a pin lying upon it, through a depth of some 8 or 9 feet; can you state what degree of clearness is of practicable attainment by the artificial filters such as you have last described?—In artificial filters constructed for the use of print and other works in Lancashire, the common water is rendered as pellucid as spring water. But it must be understood that artificial filters constructed in the usual mode, namely, of sand and gravel, will not exert any chemical action on the water, nor remove any substance with which the water is chemically combined: whereas natural filters frequently contain aluminous and other matters which exercise a chemical decolorizing influence; but an artificial filter will effect the complete removal of sand, clay, vegetable and animal matter, fish and insects; the most turbid river waters may thus be, by filtration, rendered perfectly transparent and potable.

Would not filtration be requisite for nearly all large supplies of water to towns?—Yes, for all river waters; for all hill-side waters received into catch-water reservoirs; for all waters, in fact, except spring and well waters.

What would be the separate expense of a private filter, or of a separate filter for each house of such a town, or the comparative aggregate expense of complete private filters for the whole town?—The private filter would cost much more than a shilling per annum. It would be difficult to estimate the expense of 10,000 different cares, cleansings, and renewals; but there can be no doubt that they would, if they were practicable, be vastly more expensive and less perfect than any public system of filtration.

Are you not enabled, on the large scale, with well-managed public reservoirs, to observe small changes which would not be observed, or which, if observed, would be likely to be neglected on the small scale?—Yes; having our attention constantly directed to the state of the water, and acquiring in consequence discrimination, and always observing the water in large bulk, we are enabled to perceive and anticipate minute changes, of which the users of private receptacles would be wholly unobservant; for instance, if we observe the growth of certain small aquatic plants, or—more especially if we remark ascending to the surface of the water small bubbles produced by the gases resulting from the decomposition of organic matter, we know that a *habitat* is being formed for insects, and that if this process be not arrested, insects will soon make their appearance in considerable numbers; we therefore infer from these early indications that the time has arrived at which it becomes prudent to anticipate the coming depuration of the water by cleansing out the reservoir.

Does not the principle implied in your last answer, namely, the superiority of attention, by properly qualified public officers, over any private superintendence, apply as well to the filtration as to the storage of water?—It does, and with this additional advantage, that the extraneous matters detained by filtration, some of which, as, for instance, animal and other organic remains, are of a very objectionable nature, would be very frequently removed in a public establishment, but would accumulate for months or years in a private filter.

With what degree of rapidity may filtration on the large scale be advantageously conducted?—This will in some measure depend on the thickness and quality of the filtering stratum. In general I conceive that not more than one-half pint of water should be passed through a superficial foot of fine sand in a minute, and that the upper stratum of the sand should never be reduced by the process of cleansing below two feet in thickness, the first thickness being about four feet, which will be diminished by an inch or less at each successive cleansing.

How often will the filter usually require to be cleansed?—That of course will depend on the degree and quality of the turbidity of the water, and on the perfection to which the prior process of subsidence is carried. In general a filter constructed in the proportions mentioned, and never exposed to a pressure of more than four feet of water, may require cleansing every second or third week, by the removal of a coat about an inch thick from its surface.

Then you must suspend the process of filtration, whilst this cleansing takes place?—Yes, and it is mainly on this account that I am induced to recommend the construction of subsiding tanks and filter beds in duplicate, that the process of cleansing may be carefully and not hurriedly performed, and that it may not be improperly deferred.

The one superior reservoir may then have such systematic, and sustained attention as it were impossible to find for the private filter?—Undoubtedly; the chief reservoir may have science and systematic attention, and the advantages in point of economy which are incident to an extensive and well-conducted establishment. The private filter is in practice only used to render small quantities of water suitable as a beverage; but the filter on the large scale purifies the water, as already stated, for culinary uses, for the laundry, for baths, and for every other purpose.

Then you regret that those works you proposed for Newcastle were not executed?—Scarcely so; for their execution would have involved a long, and acrimonious, and expensive competition between the two Companies; but I conceive that the present Company and the town would be greatly benefited

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by the adoption of such portions of these works as would be necessary for receiving the water with rapidity at the most suitable period of the tide, and for extending and improving their existing means of subsidence and filtration.

What would be the expense of effecting this purpose?—About 5000*l.* or 6000*l.*

But you have stated that it would have cost the old Company 17,000*l.* or 18,000*l.*?—Yes, but the new Company had already an engine, main, reservoirs, and various other apparatus, nearly adequate for the supply of the whole town, which they had been obliged to erect for their own purposes.

Then the difference of expense may be taken as an example of the economy of one establishment over two, in the one field of operations?—Undoubtedly; and the annual expenses would be proportionately reduced.

And the non-expenditure of the sum of 5000*l.* for so important a sanitary purpose as the complete purification of the beverage, and water used by 50,000 people may be taken as an example of the necessity of some disinterested, supervising, or controlling authority to ensure proper compliance with the intentions of the Legislature in granting such exclusive privileges, and attention to the wants of the public?—I conceive so.

Where means of natural filtration are not possessed, do you think, regarding the importance of pure water for the labouring classes, and even the importance of clean water for steam-engines and for washing the streets, that artificial filters should be *required* to be used?—Convinced of the great evil and the uselessness of legislating in detail on these subjects, and at the same time of the necessity for the existence of some disinterested authority intermediate between the Companies and the public, I think that such a discretionary power ought to be delegated to a competent and responsible authority, having a judicial position and responsibility, who would, in every instance, inform itself of the circumstances of the Company against whose water complaints might be made, and of the facility (if any) afforded by the adjacent country for furnishing the requisite materials for the construction and maintenance of a filter-bed, and who should prescribe what additional rates should be levied from the public in respect of additional expenses incurred for such public accommodation.

What on such arrangements as those you have described would be the extent of ground requisite for filter beds, and for reservoirs of subsidence and storage of a supply of water for the metropolis?—The filter reservoirs would in extent be about equal to the square of Lincoln's Inn Fields, or at most 15 acres. The magnitude of the subsiding tanks would entirely depend upon the state of the river water at the spot

from which the water might be taken: at a guess, I might say 30 acres. The storage reservoirs need not be very extensive in consequence of the number of engines which would be brought to work into them being considerable, and so constituting a sort of water-insurance company. I presume 15 or 20 acres, 8 or 10 feet deep, would be very ample.

Will not it be of advantage that all such reservoirs of the kind should, as far as possible, be out of the reach of any deposit of the soot or dust of a town, or of the fall of rain passing through the sooty and polluted atmosphere of the town?—Yes, for the water washes the ribbon of air which passes over the reservoir. This ribbon will on the average measure 250 miles per diem. Moreover, the rain falling through the air of large towns acquires and carries down into open reservoirs a considerable quantity of polluting matter. I see no reason why the water used in London should not be taken from the Thames at or above Windsor, and be stored on the high grounds in the neighbourhood of Hampstead.

Would the distance of the site of the filtering and subsiding reservoirs occasion such expense or inconvenience as to prescribe close limits?—No, the engineering difficulties would be very insignificant, and the expense really trifling in comparison with the resulting advantages. Not the least of which would be the securement of an unfailing supply of pure water for several ages to come.

If for the supply of the metropolis it were found desirable to take up the water of the Thames in its full purity above Windsor, and erect filters or subsiding beds thereabout, what would be the probable expense of its transmission above a supply taken up near the metropolis?—For the transmission of 500 gallons of water per second two mains, each of 60 inches diameter, would be requisite. The resistance from friction may be calculated from the formula for long pipes

$$P = \frac{Q^3 l}{140 d^5},$$

in which (P) represents the horse-power necessary to overcome the friction, (*l*) the length of the pipe in inches, (Q) the quantity of water to be delivered in one second, and (*d*) the diameter of the pipe. From this we ascertain that the resistance arising from friction in pipes of the given size, and 25 miles long, would require less than 450 horse-power beyond the force employed to raise the water into an elevated reservoir. If this reservoir were situated at a height of 220 feet, the steam-power required to *raise* the water would be about 2000 nominal horses, and the total power to be employed in transmitting and raising 500 gallons of water per second would amount to less than 2500 horses. The cost of the main pipes

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would be about 1,000,000*l.*; of the engines and machinery, with some reserve of power, about 150,000*l.*; and of the tanks and reservoirs probably 200,000*l.* A first investment of 15*s.* per head, or 9*d.* of addition to the annual water charge of each of the population would therefore enable a constant supply of the purest soft water to be delivered at all hours, and into every story throughout London, and that without injury to the interests of the existing companies who might derive their supplies from this common source. A *very* considerable economy of management and working expenses would indeed result from this consolidation of engineering operations which would go far in reduction of the increased charge of 9*d.* per annum.

From this large example may it be inferred as a general principle that the distance from the town forms an inconsiderable addition to the cost of water supplies where recourse may be had to any upper portion of a river to obtain greater purity?—The table I have already given will, I apprehend, resolve this question in a general way. I hold the opinion that the cost of transmission is mostly very inconsiderable, of course the interest on the money invested in the additional length of main pipe must be defrayed by the community benefited. To convey water to a town of 40,000 or 50,000 inhabitants from an *additional* distance of three miles would probably increase the annual charge about 4*d.* per head.

Have you considered the subject of public baths?—Yes, I have been consulted in respect to public baths, and have been engaged in making some private baths.

On the assumption that one hogshead, or 54 gallons of water, would suffice for the ablution of each person, what would be the cost of pumping and engine expenses for 100 persons per diem?—Threepence.

Suppose this water filtered, what would be the extra expense of filtration by artificial means?—Something less than 2*d.*

What would be the expense of fuel for heating 100 hogsheads of water from a mean temperature of, say 52 degrees, for baths, to blood heat, or say 98 degrees?—It would require 270 lbs. of Newcastle coal, which would cost in London about 3*s.* In addition to this, a further quantity of fuel would be required to replace the heat lost by radiation, evaporation, and conduction, which would be subject to great variation according to circumstances. An equal quantity of coal would in general, however, be sufficient for this purpose. On a larger scale there would be some saving.

If, then, the population were a bathing population, and used warm baths in large numbers, the expense would be inconsiderable?—Yes, certainly; for the whole expense of hot baths in numbers of not less than 100 per diem would stand nearly thus for each person for the single bath:—

	s.	d.
Water	0	0 $\frac{1}{4}$
Fuel	0	0 $\frac{1}{2}$
Attendance	0	1
Interest on building and incidentals .	0	1
	<hr/>	
	0	2 $\frac{3}{4}$

Then you think that warm baths might be provided for the working classes in large numbers for about 3*d.* each?—Yes.

It is perhaps during only a short period of the year in this country when the weather would permit cold open swimming baths to be used with comfort, especially by a town population, who would have the less opportunity to go to a distance where such baths or open bathing places must generally be situate?—I conceive that in this climate even a swimming bath ought to be covered, and somewhat warmed; the rain and cold will otherwise militate so much against comfortable and convenient enjoyment as to prevent the habit of bathing being acquired and persevered in.

What would be the probable cost of maintaining a tepid swimming bath, suppose 80 feet long and 30 feet wide, and of the average depth of 5 feet, supposing 10,000 gallons of fresh water daily admitted into it?—To warm the quantity of water admitted, about 2 cwt. of coal would be required, and it would probably in practice require 4 or 5 cwt. in addition to sustain the temperature of the bath. A remunerative charge for the use of the tepid bath would probably be about 2*d.* per head, if taken by 200 or 300 persons per diem.

Of course the system of keeping on the constant supply of water would greatly govern the convenience and economy of public baths?—Certainly. The public baths at Nottingham, which, however, are not intended for the working classes, have entirely arisen out of the system of constant supply, and must be closed if that system were abandoned.

What use is made of the system of constant supply at high pressure at Nottingham for private fountains in houses and gardens?—Many of the apothecaries have small fountains in their shops; some gentlemen have small fountains in their gardens, and others have also jets in their gardens for washing the trees and plants.

With these jets, then, are they not enabled to wash the taller trees?—There are not many gardens in the town, but in several instances they cleanse pear trees and fruit trees to the top, as high as their houses, by this process.

Would not the system of constant supply, at high pressure, be often more extensively applicable for the cultivation of market gardens in the suburbs, or within the vicinity of the water-supplies?—Yes; it would, with pipes properly laid in

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the gardens, afford a cheap means of an immediate distribution of water, such as could not be obtained in the ordinary mode by hand labour.

What would be the quantity and expense of water for a smaller sized public fountain on this system of constant supply? —A jet delivered under a pressure of 36 feet through a plate pierced with a half-inch aperture, would deliver 900 gallons per hour to a height of 30 feet or upwards, at an expense of $2\frac{1}{2}d.$ per hour.

That would be the Company's charge at Nottingham? —Yes; an inch orifice would deliver four times this quantity to a height somewhat greater, and would be charged about $8d.$ per hour.

That is to say, not simply at the extra charge for pumping, but at the Company's charge, yielding what you consider the fair rate of profit? —Yes.

Suppose the water works maintained by the town, and that it was determined to supply the public fountains at the expense of pumping only, what would the half-inch jet cost per hour and per diem, and what the inch jet? —Including coals, wages, and the working expenses of the engine, it would amount to very nearly one halfpenny per hour, or for a day of 14 hours, $7d.$ per diem. The inch jet would cost $2d.$ per hour, or $2s. 4d.$ per diem. This is the cost at Nottingham, where the water is raised 135 feet; but under other circumstances it might be less.

What might be the cost of pumping only for small way-side fountains delivering, say one or two hogsheads of water per hour? —From $\frac{1}{2}d.$ to $1d.$ per diem.

Are jets in use for watering streets at Nottingham as substitutes for the ordinary mode by water-carts? —Yes, in some instances; but it has not yet become general, as there are no public officers charged with the service.

What is your charge for jets for this purpose? —The rule of assessment is one halfpenny per square yard of surface watered, if for small surfaces, and one-third of a penny if for extensive surfaces, for the season.

In the metropolis, the charge for water for watering the streets is sometimes $2\frac{1}{2}d.$ per ton, and one ton it is ascertained will water so as to lay the dust of 600 square yards of gravel or Macadamized roads, or 400 square yards of granite paved roads. It appears that the number of days for which the water is required to lay the dust is, on the average of 20 years' experience, about 120 per annum. A common charge is three farthings per square yard for the water for a season, when it is watered only once per diem, or $50l.$ per mile of a main road when it is watered no oftener. The common assessment for watering roads twice a-day is usually $1l.$ per house for the

season. When the parishes perform the service, it is usually at from $1\frac{1}{2}d.$ to $2d.$ per pound on the rental. Now what would be your charge of the expense of water per house of 20 feet frontage for the season?—Our charge for the supply of water to a street one mile long and 15 yards wide between the kerbstones, would, by our charge per ton, be $16l.$; for twice over, $32l.$; which with houses of seven yards frontage would be a charge of $1s. 6d.$ per house, or allowing for occasional vacant spaces in the row of houses, say $2s.$ per house for the supply of water during the like season.

What might be the expense of labour to water the streets twice per diem?—I think one man might, with proper and properly-placed apparatus for jets, effect the watering of about one mile of such road twice per diem. Supposing the wages to be $20s.$, and expense of hose $10s.$, or altogether $30s.$ per week, the additional expense for labour would be about $1s. 6d.$ per annum (omitting the Sundays), or allowing for vacancies, say $2s.$

What would be the expense of cocks, and the investment of capital for these purposes?—I conceive that if done in the best manner the primary extra expense of apparatus would not amount to $400l.$ per mile, and in general would not exceed $300l.$ per mile, or a charge, say of $20l.$, or $1s.$ per house per annum.

That is to say, on the system of jets, about $5s.$ per house per season for watering the roads twice per diem?—Yes; our charge at Nottingham for a single street plug, which some shopkeepers have in the fronts of their own premises, is $7s. 6d.$ per annum, but in this case the individual supplied always uses the water considerably beyond his own frontage; sometimes two or three houses on either side will obtain the benefit.

It is stated that in some of the streets of the metropolis, and in other towns where there is much traffic, sickly or sensitive persons often perceive an oppressive effluvium after the carriage ways have been recently sprinkled with water, the reason assigned being, that the ammonia or the volatile portions of the horse dung or droppings of the cattle (which in the space of wood pavement between the Circus and the Quadrant in Regent-street is found to be on the average about three loads of dung per diem, or after the rate of eight loads per mile), are given off with the moisture evaporated. Do you not consider that this process of watering the streets should be placed under the guidance of better discretion than that of the common labourers, and that with the facilities of more rapid watering, and in some instances scouring by jets of water early in the morning, or otherwise by more complete early cleansing away of the dung and mud, which is usually only moistened for evaporation, might be removed, or considerable improvements be effected? Have you made any observations on these points?—I have

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made no special observations on the subject. Some, however, of the more frequented streets in particular states of the weather smell like a stable. The smell is more often perceptible in the summer immediately after watering, and when there will be a quicker evaporation than in winter. Constant residents in London are less sensible of the street effluvium than persons who have spent some portion of their time in the purer air of the country. I entertain no doubt that the application of water to the surfaces of roads and streets is capable of great improvement. The provision and application of water for all public purposes ought to be under one management, by which much expense and inconvenience would be spared.

Might not the foot pavements in this case fall under the same management as the carriage pavements, and in the instance of a mile of street, containing 500 houses, a few men save as many separate and disagreeable operations by as many domestic servants?—Certainly.

Would not the arrangements for watering the roads by jets from plugs or cocks be applicable to the scouring of pavements and carriage-ways in dirty weather and to the flushing of sewers?—It would; for the removal of the unctuous mud, which in certain states of the weather collects on the wood pavement and the stone causeways, scouring by jets would be of the most perfect effect. No broom, unaided by water, will sufficiently remove this unctuous matter.

It is stated that an ordinary sweeper usually sweeps 1000 square yards of pavement per diem, and a good labourer of the class about one half more, and that the expense of sweeping by hand labour is between 2*l.* and 3*l.* per mile of street 15 yards wide. Have you had any observations of the labour and expense of the more effectual mode of cleansing granite or wood pavement by scouring with a jet?—No precise observations. I have seen an open space of about 1500 square yards of level pavement cleansed in less than 20 minutes by water acting under a pressure of 80 feet.

In respect to the watering of gardens, it would appear that one man with a jet of the force to rise 50 feet perpendicular height would with that one jet, at an angle of 45 degrees, command an area of about 2000 square yards. From your information, that about 40 jets would command a length of a mile of road, and that one man might water that mile twice a-day, may it not be inferred that by a proper distribution of pipes and arrangement of cocks one man might water 20 acres of garden ground in a day?—Yes; for although two miles of such a road contains only 10 acres, the range commanded by an equal number of jets would in a garden command twice that area, and the interruptions would be much fewer than in a public road.

It is stated to be a heavy wetting shower when the excess fills gutters, and, running away, covers the ground to the depth of a quarter of an inch. How many tons of water would fall in such a shower on an acre?—A fall of rain sufficient to cover the earth to a depth of $\frac{1}{4}$ th of an inch will, under ordinary circumstances, fully saturate the dust of a public thoroughfare: this quantity is equal to 750 gallons, or about $3\frac{1}{2}$ tons, or 2 loads of water per acre.

In what time would such a quantity be delivered from a hose by a jet under the moderate pressure of 50 feet?—The velocity, and consequently the time, will in some degree depend upon the arrangement of the apparatus: a *contracted* jet, issuing under a pressure of 50 feet, at a $\frac{7}{8}$ ths aperture, will deliver 750 gallons in 14 or 15 minutes: a judiciously formed nozzle will deliver the same quantity in 10 minutes.

In what time would it be distributed by cart labour?—The time would be vastly greater, but how much greater I cannot say.

What would be the rate of expense of laying down a set of water pipes per acre?—From 15*l.* to 30*l.*, according to circumstances.

Then at the cost of supply at Nottingham of 3*d.* per 1000 gallons a fall of water equivalent to a shower would be given at 2 $\frac{1}{4}$ *d.* per shower per acre?—Yes.

Would not this street watering or street cleansing apparatus be available for the extinction of fires, and be easily found and easily applied from its being in constant use?—Yes, and would be more conveniently and rapidly applied than any arrangement of fire-plugs.

Have fires been frequent at Nottingham?—Very infrequent. There have been only two serious fires within the last 10 years; but at one of them, the fire at the Exchange, if the water had not been on at the time at high pressure, which enabled a quick delivery of water (at the estimated rate of delivery of 1200 gallons per minute) all round the building, the fire would, in all probability, have been as extensive as the recent fire at Hamburgh.

What is the height to which jets from the smaller mains of three inches and upwards rise at the extreme points of delivery?—It will, in general, be about half the height due to the pressure. On an average level, jets of water are thrown over three and four-story houses. On a recent occasion water was thrown from the $\frac{1}{2}$ -inch nozzle of a hose-pipe, attached to a stand-pipe fixed in a 2-inch fire-plug at the extremity of a 3-inch main, on to the roof of a four-story house, the estimated height to which the water was projected being 48 feet, the $\frac{1}{2}$ -inch nozzle delivering about 30 gallons a minute. With proper arrangements a fire-plug might be knocked out, and a

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hose attached in two minutes. On the occurrence of a fire, one such jet, at the least, might be brought to bear in two minutes upon any house in which a fire occurs.

In country towns how soon, on the average, is a fire engine brought to the spot and set to work?—Not on the average in less than half an hour certainly.

It is stated by Mr. Braidwood that, in London, 26 men working an engine of two 7-inch barrels will throw a $\frac{1}{8}$ th of an inch jet 50 feet high; and the following is an account of some experiments made at the works of the Southwark Water Company, to ascertain the capacity of the existing works to afford several jets for street cleansing or for extinguishing fires.

“ Result of Experiments made on the 31st January, 1844, to ascertain the Height that a Jet of Water will rise from the Mains and Services belonging to the Southwark Water Company, under a Fixed Pressure of 120 Feet.

“ The first trial was made in Union-street, between High-street and Gravel-lane, Borough, over an extent of 800 yards of 7-inch main, and through the fire-brigade stand-pipes, hose, and jets.

“ This 7-inch main is connected to the 9-inch main in the High-street, Borough, which, after a run of 500 yards, is joined to 200 yards of 12-inch main, and then continued by 550 yards of 15-inch main to the great main leading from the Company’s works at Battersea, making a total distance of 5500 yards from the place where the experiment is made.

One	$2\frac{1}{2}$ -inch stand pipe, with 40 feet of hose, and $\frac{7}{8}$ -inch jet, rose 50 feet.
Two	$2\frac{1}{2}$ „ „ 40 „ $\frac{7}{8}$ „ 45 „
Three	$2\frac{1}{2}$ „ „ 40 „ $\frac{7}{8}$ „ 40 „
Four	$2\frac{1}{2}$ „ „ 40 „ $\frac{7}{8}$ „ 35 „
Five	$2\frac{1}{2}$ „ „ 40 „ $\frac{7}{8}$ „ 30 „
Six	$2\frac{1}{2}$ „ „ 40 „ $\frac{7}{8}$ „ 27 „

“ Then all the fire-plugs on the main were closed except the first and $2\frac{1}{2}$ -inch one stand-pipe, with 160 feet of hose, and a $\frac{7}{8}$ -inch jet rose 40 feet.

“ The quantity of water delivered from the same main through one stand-pipe and different lengths of hose was as follows, viz. :—

One	$2\frac{1}{2}$ -inch stand pipe, 40 feet of hose, $\frac{7}{8}$ -inch jet, delivered 96 gals. in 59 seconds
One	$2\frac{1}{2}$ „ 80 „ $\frac{7}{8}$ „ 112 „ 65 „
One	$2\frac{1}{2}$ „ 160 „ $\frac{7}{8}$ „ 116 „ 70 „
One	$2\frac{1}{2}$ „ 40 „ $\frac{1}{2}$ „ 118 „ 27 „

“ The second trial in Tooley-street off a 9-inch main, 1400 yards in length, connected to 1000 yards of 15-inch, and 6650 yards from the works.

One	$2\frac{1}{2}$ -inch stand pipe, 40 feet of hose, $\frac{7}{8}$ -inch jet, rose 60 feet.
Two	$2\frac{1}{2}$ „ 40 „ $\frac{7}{8}$ -inch, difference not perceptible.
Four	$2\frac{1}{2}$ „ 40 „ $\frac{7}{8}$ -inch jet, rose 45 feet.
Six	$2\frac{1}{2}$ „ 40 „ $\frac{7}{8}$ „ 40 „

“ Quantity delivered from the same main through—

One	$2\frac{1}{2}$ -inch stand pipe,	40 feet of hose,	$\frac{7}{8}$ -inch jet,	114 gals. in 64 seconds.
Four	$2\frac{1}{2}$,,	40 ,,	$\frac{7}{8}$,,	115 75 ,,
Six	$2\frac{1}{2}$,,	40 ,,	$\frac{7}{8}$,,	112 78 ,,

“ Four-inch service in Tooley-street, 200 yards long, supplied through 200 yards of 5-inch pipe, from 9-inch main one $2\frac{1}{2}$ -inch stand pipe, fixed on the 4-inch service near the 5-inch pipe, with 40 feet of hose $\frac{7}{8}$ -inch jet, rose 40 feet; two $2\frac{1}{2}$ -inch stand-pipe $\frac{7}{8}$ -inch jet, rose 31 feet.

“ One $2\frac{1}{2}$ -inch stand-pipe fixed at end of service.

200 yards from 5-inch pipe,	40 feet of hose,	$\frac{7}{8}$ -inch jet,	rose 34 feet.
Two $2\frac{1}{2}$ -inch stand pipe,	40 ,,	$\frac{7}{8}$,,	23 ,,

“ Quantity delivered from the plug near the 5-inch main through—

One	$2\frac{1}{2}$ -inch stand-pipe,	40 feet of hose,	$\frac{7}{8}$ -inch jet,	112 gallons in 82 seconds.
Two	$2\frac{1}{2}$,,	40 ,,	$\frac{7}{8}$,,	117 103 ,,

“ Quantity from end plug of service 200 yards from the 5-inch main—

One	$2\frac{1}{2}$ -inch stand-pipe,	40 feet of hose,	$\frac{7}{8}$ -inch jet,	112 gallons in 90 seconds.
Two	$2\frac{1}{2}$,,	40 ,,	$\frac{7}{8}$,,	114 118 seconds.”

In confirmation of these results it is stated, in answer to some inquiries made at Philadelphia, that “ the water will rise from a hose attached to a fire-plug in the street at the extreme point of delivery, during the night to the height of about 45 to 50 feet. During the day, when the consumption of water is very great, it will not rise more than 20 to 30 feet.” Do these results correspond with your experience and observations?—Yes, they do. But it may be well to state that the great diminution of velocity, and consequently of elevation, observable in the least favourable experiment of each set, is to be chiefly attributed to the great aggregate area of the jets in proportion to the area of the stand-pipe and hose.

Although the height to which water will rise from jets is in general, in consequence of the resistance of the atmosphere, half the height due to the pressure, will it not, in a hose or in a pipe, rise to the full level, so that it may be poured out to extinguish fires, or used for any purpose from the full height? —When the water is not in motion, it will rise to the level of the reservoir. When it is in motion, there will be friction in the main pipes, by which the height will be in some degree diminished. When the main pipes are of considerable size, compared with the area of the jet, this friction will be insignificant. The higher water is carried in a pipe, or the higher the nozzle of a hose-pipe is carried, the more the resistance of the atmosphere is avoided. If a jet acting under a pressure of 100 feet attained an elevation of 50 feet when discharged from the level of the pavement, then if the hose-pipe were elevated to the height of 50 feet, a jet would still be given of probably 20 or 25 feet high. By this means the water would attain

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an elevation of 70 or 75 feet, in place of 50 ; hence the advantage of carrying a hose-pipe up stairs, or up a ladder, or as nearly as possible to the height of the story where the fire occurs. Another advantage gained by carrying up the hose-pipe is a better direction of the jet, and more certain application of the water than can be had from the ground.

The advice of Mr. Braidwood, the Director of the Fire Brigade in London, being requested as to the best mode of protecting the British Museum from fire, he advised that that building should be surrounded with mains kept constantly filled with water at high pressure. This has been done. Now, wherever the system of constant supply at high pressure is adopted, will not the same result as to increased safety be produced in its degree for every house within the reach of a hose, attached to a main?—Certainly it may, especially if practised firemen or policemen be in readiness to apply the apparatus ; otherwise it is to be feared that the usual want of presence of mind on occasion of fire may sometimes interfere with the success of the arrangement.

The following evidence has been given as to the experience of the application of the constant supply, at high pressure, to the prevention and extinguishing of fires at Preston :—

“ SAMUEL BRADLEY.

“ Q. How long have you been Superintendent of the Fire Police in Preston?—A. Three years in Preston and 16 years in the Manchester Fire Brigade.

“ Q. Have you had any fires lately?—A. There was one in a cotton warehouse about two weeks since. The fire was put out with the hose without the engine. The hose is on a reel on the engine, but we much prefer to use the hose alone. We unwind it, screw it on the plug, and use it instead of the engine. For the last two years we have never used the engine. The hose is more effectual and more rapid in its operation. The water by the hose can be thrown over the highest building.

“ Q. Why do you prefer the hose to the engine?—A. Because it is much more handy, can be easier taken into any part of the building, and requires much fewer hands to manage it.

“ Q. Do the factories keep hoses?—A. Several of them do ; Mr. Rogers, of Pitt-street, has such a hose, and he has put out a fire at least once, I think twice, by the hose before the engine was called.

“ Q. From your experience in the Fire Brigade in Manchester, do you think that by means of the hose screwed to the water-plug you can extinguish fires more quickly than could be done in Manchester with the engines?—A. In Manchester there was some delay, owing to the water being off at times. Here they can put on water in 30 seconds after reaching the fire, and the pressure being stronger at night in the main than in the day (owing to there being no use for it at that time), I am sure the system pursued here is more effectual and rapid.

“ Q. Would it not be much better to have a hose reel, or hoses, in

“different parts of the town, instead of dragging up to the fire a heavy engine, which you do not use?—A. It would be very much better, and I am very anxious that the Commissioners of Police would enable me to do so. The reel must be on a spring-cart, in order to carry the ladders also. The ladders are very useful in the case of the hose. I am sure if we had a reel I could reach a fire in a quarter of the time that it now requires with the engine.”

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Do you conceive that such applications of the system of constant supply, at high pressure, are generally available? —Yes, I do; more particularly in the provincial towns where a regular fire brigade cannot be maintained, and in most cases such means would, when unable to subdue the fire, serve to keep it in check until the arrival of the engines and firemen.

For small streets they usually send three engines; for larger streets, such as Portland-place, six or eight engines. Now, will not a 3-inch service pipe, or more, such as would be used in the smaller streets, afford one or two jets, a 6 or 7-inch main, afford at 150 feet pressure 6 or 8 jets, and a 9-inch main at such pressure afford many jets?—Yes, a 9-inch main would afford more jets than could perhaps be brought to bear on any ordinary fire, and might be expected to deliver water through nozzles of 1 inch diameter to a height of 80 feet, especially if the plug branches were of proportionate diameter.

What would in general be the expense of inserting a fire-plug in a 3-inch service pipe, or in the larger mains?—In a small service pipe the expense might be about 20*s*. The expense would vary with circumstances; but I conceive that sufficient plugs might, in general, be inserted in most mains and service-pipes at an expense of from 20*s*. to 30*s*. each.

For how many houses would one plug serve?—I think it would suffice if they were 50 yards apart, or one to seven houses in length of street. No house would then be more than 25 yards from a fire-plug. At an expense of 25*s*. per fire-plug the first cost would be about 2*s*. per house, in the case of a main laid down the middle of a street for the supply of both sides. This at 10 per cent. is equal to a rent-charge of 2½*d*. per annum; or about one-fifth of a penny per week.

Have you not stand pipes which afford two hoses and two jets to one plug?—Yes, we devised such a plug at Nottingham, and I have since learned from Mr. Braidwood that such an apparatus has been long in use in London for feeding the fire-engines. It would be practicable to have a stand pipe to supply three or four jets at once, if the service-pipes and fire-plug apertures were properly proportioned.

It is stated that, as an additional means of securing warehouses or premises of value, a water-tank is sometimes placed at the top of the premises, and a pipe is carried from thence through

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each room and down to the basement. There is a plug or cock opening from the pipe into each room, so that a hose may be at once attached and a jet at once brought to bear upon any part of the room which may be on fire. This appears to be carrying the principle of a constant supply still closer as a means of prevention; and instances are stated to have occurred recently in Manchester of fires being at once extinguished in buildings so protected, which would, it is confidently believed, have been certainly destroyed, and property of the value of from 50,000*l.* to 100,000*l.* have been consumed if it had been necessary to wait the usual time for the arrival of fire-engines and for their getting to work. Have you had any buildings so protected on the system of constant supply at high-pressure at Nottingham?—Yes. We have several mills and factories protected at Nottingham by 3-inch pipes, which pass from the main up the staircase, with branches into each room. In several instances a branch main is carried into the premises, and fire-cocks are provided; a timber-yard and at least one chapel is so protected.

On the system of constant supply at high-pressure, you enable the parties to dispense with the expense and inconveniences of tanks on the roofs?—Yes, and render it much more safe. The tanks might be soon out of water, but the communication from the Company's main would bring to bear, if necessary, the whole contents of their reservoir. The private tank may, besides, be frozen, or it may have been neglected, and be out of order and empty at the time its services are required. This was the case with much of the apparatus kept in the Tower; when required for use at the late fire it was found to be unavailable.

What may be the expense of such a mode of protecting a warehouse, say 60 feet high?—It would be about 25*l.*

What additional rent would it involve for apparatus and supply?—Presuming that no additional water would usually be consumed, we charge at Nottingham nothing additional for the supply to the fire-pipes. The additional rent would be about 2*l.* 10*s.* to cover interest and wear and tear.

What would be the expense of such an apparatus, with a water-tank on the roof, on the system of occasional supply?—The expense of such an apparatus, with a sufficient water-tank, would be about 100*l.*

This arrangement, then, brings to bear on the premises, in a few minutes, the force of several fire-engines?—Yes.

It would be a small warehouse, would it not, where the annual insurances would be 20*l.*?—Yes, I conceive it would.

And the insurance of some extends to 600*l.* per annum and upwards?—Yes.

Suppose that, for the sake of the increased security, under a

system of constant supply at high-pressure, there were laid down in the streets of the metropolis, containing warehouses or valuable property, large mains, say of 9 inches (where, for all purposes of ordinary supply, small service-pipes would perhaps suffice), mains to be used chiefly in case of fire, under such an arrangement as that around the British Museum, what would be the expense of such mains, supposing the large house or warehouse to have a frontage of 60 feet?—The additional expense of such a main over a 3 or 4-inch service pipe, including additional fire-plugs, might be about 10*l.*, involving an additional rent of 1*l.* to each such warehouse, in any place where there is a continuous line of warehouses. It is right to observe, that, under the present state of things recognized by the law, public companies are not authorized, and, indeed, are in effect prohibited, from expending such an amount of capital as would be requisite and would be involved in general works of the magnitude presupposed by this question. The Acts by which water companies are now established and governed only authorize them to expend such sums of money as may be necessary to effectuate the purposes contemplated by the Act; such, for instance, as domestic supplies, supplies for trade and manufacturing purposes, for steam-engines, public baths, and other like purposes. The supply of water for the extinction of fire is scarcely more than incidentally alluded to. The fixing of fire-plugs is usually, but not in every instance, imposed by the Legislature; and even in this case no compensation is granted in respect of the companies' expenses, nor is any return made for the supply of water afforded. It is not, therefore, the fault of the water companies if more effective arrangements are not made for the prevention and extinction of fire.

If preventive arrangements were made on a comprehensive and efficient scale, and a fair remuneration afforded for the capital invested, is there any reason to doubt that such arrangements would effect a large pecuniary economy independently of the necessary abatement of the pain experienced in society from continually witnessing and apprehending devastation and loss of life by fire?—It cannot be doubted that much of the usual loss by fire would be entirely prevented; nevertheless, the reduction upon insurances would be comparatively trifling. The charges of Insurance Companies are made up of the Government duty, the cost of management and agency, the interest of capital, and the proportion necessary to replace the losses by fire. The Government duty, which amounts to two-thirds of a common insurance, would remain unaltered, and the other items, except the proportion of charge necessary to replace losses, would be little affected. In consequence of the very unnecessary number of insurance offices,

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the cost of management is very considerable, and the investment of capital unnecessarily great. It is believed that not more than 1*s.* is charged in respect to risk upon an insurance for which 4*s.* 6*d.* is paid. From this it follows that the reduction of the rates of insurances consequent upon the adoption of preventive arrangements cannot, except in very special cases, be considerable.

It is stated, in the answers returned from Philadelphia, "that the present system of watering the city has reduced insurance risks in the proportion of one to three upon the real estate, but not upon goods, wares, and merchandize: these are considered almost as a total loss from the damage by water." Speaking of insurance risks in general, as affected by all the improved arrangements attendant upon the change of system, it is stated that those risks are taken at one-half the premium chargeable in other cities where the arrangements are incomplete. Is it the fact that, on the introduction of the system of constant supply at high-pressure at Nottingham, an insurance company was got up for Nottingham, on the ground that the increased security obtained by the improved supply of water would render insurance, on the ordinary terms, a peculiarly safe and good investment?—Yes; for, though this might not be stated in the prospectus, it was held out as an inducement to persons to become proprietors. The Trent Water Company was urged on these grounds to become an insurance company. But that Company thought the scheme was not within their line of duty, and they therefore declined to take it up, and then other parties took it up.

Has there been a Company formed on the ground of the premium being lower in consequence of those improvements in the supply of water?—No; the premium is no lower at all. I think it was formed that they might thereby be enabled to secure to themselves the profits which the London Companies would otherwise get.

Have you had occasion to consider, as a branch of hydraulics, the system of sewage and drainage of towns?—Yes, I have; and have made numerous calculations, and conducted investigations, with relation to the drainage of towns in connection with the supply of water. A good supply of water will be of little value without an efficient drainage.

Will you afford the Commissioners the results of your investigation, but now answer some general questions?—I will endeavour to do so.

Under what circumstances do you consider the utility of the supply of water to be influenced by the defective state of the drainage?—Where one system terminates the other must commence. The use of water, however liberally supplied, will be limited and restricted by any inconvenience attending its

removal. Its use as a means of cleansing and removing refuse, by the application of the water-closet principle, will be directly dependent on the state of the drains. If the drains be ill adapted, badly constructed, or laid at such small depths below the surface, that sufficient falls cannot be obtained, foul matter will accumulate in the lateral drains, and annoying stoppages will take place, and injurious stenches will arise. In making these observations, I take it for granted that it is now conceded by every one that cesspools and privy-pits are not less detrimental to the health than unpleasant to the senses, and that there cannot be a really healthy population living in the vicinity of such receptacles.

Have you had occasion to direct the introduction of soil-pans into buildings, in substitution of privies and cesspools, or to observe their substitution?—Yes; they are in use in several public buildings in Nottingham, and they answer extremely well when there is a sufficient supply of water; but the public companies object to afford such supply, because they have as yet no sufficient check on the consumption.

Do you not think that some cheap means may be found to obviate that difficulty?—Yes; I think something may. Indeed, I have been favoured with the view of an apparatus invented by Mr. Smith, of Deanston, which seems to supply this desideratum.

What material do you find the best for the description of apparatus in question?—Glazed pottery-ware, which may be strengthened by being set in brick and cement.

Do you doubt that, with a proper supply of water, for the poorest dwelling, a soil-pan is more economical than a privy or a cesspool?—Generally more economical, and always more desirable. In some towns, where money is given for the contents of a privy-pit, the pecuniary economy is not so apparent; but even then the cleanliness and comfort is a substantial economy, though not perhaps easily reducible to a money value.

Do you doubt the propriety in all old urban districts, which have a proper supply of water, of prohibiting, on sanitary grounds, the further use of the privy or the cesspool?—I have no doubt whatever. On the introduction of sanitary regulations into old districts, which I take for granted will be the case, the substitution of apparatus of this kind, in lieu of the present injurious and noisome privies, will affect a real saving to the proprietors, inasmuch as they will thereby avoid the necessity of removing the existing structures and building others.

It is stated that on the average the cleansing of the night-soil, or similar refuse, when it is done in a manner which is deemed proper, requires the labour of the removal of two cartloads of manure per annum from each tenement occupied

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by a family. The *contract* price for such labour in London is stated to be about 10s. per load, and the expense of such cleansing in the poorer districts is about 1*l.* per tenement per annum. This for the poorest tenements occupied by weekly tenants is the landlord's charge, and amounts to 4½*d.* per week, exclusive of the rent or expense of digging and bricking a privy, or a cesspool, which may incur a rent of at least one halfpenny a week more. Now what, if large numbers were used, would be the expense of glazed earthen soil-pans and pipes, of the same material, with the syphon or other cheap and effectual trap communicating from the soil pan, say in the back part of the house, or where the privy, whether a single privy or a common privy, whether inside the house, in the back kitchen, or outside the house, in the yard, or at the end of a court?—The expense of a glazed earthen soil-pan or basin, with glazed trap, and eight feet of 5-inch pot-pipes would, if manufactured on a large scale and fixed by practised workmen, amount to about 25*s.* Blue glazed ware of red clay, of similar manufacture to an ordinary pipkin, might be provided and fixed for 15*s.* or 16*s.*

Would not tile-tube drains, of 10 inches diameter, or thereabouts, suffice for the drainage of small courts?—Such drains would be ample if the tenements were sufficiently and constantly supplied with water.

What would be the expense, per tenement, of such a drain?—In Nottingham the expense of a *central* drain of this kind would be about 6*s.* per house; in other towns, less closely built, the expense would probably amount to 10*s.* or 12*s.* per house, and with the lateral drains to about 15*s.* per house.

What would be the lowest expense of a proper water-pipe and tap, and laying it on the house, supposing numbers were done?—Supposing the tenements to be arranged in courts, and on one side of the courts only, and each house to present a frontage of 15 feet, the pressure of the water to be about 80 feet, and the length of the court to average eight dwellings, the expense would stand thus:—

	£.	s.	d.
Fifteen feet of partly 1-inch and partly ¾-inch pipe, of the average strength of 12 lbs. per yard = 60 lbs., at 3 <i>d.</i> per lb. laid down . . .	0	15	0
Six feet of ½-inch branch pipe, of the strength of 8 lbs. per yard = 16 lbs., at 3 <i>d.</i> . . .	0	4	0
½-inch cock	0	3	6
Three joints of solder and labour	0	3	0
Opening and reclosing, and repaving the ground, and cutting the hole through the wall, and staying the pipe, 2 <i>s.</i> to 6 <i>s.</i> according to circumstances, say averagely . . .	0	4	0
	<hr/>		
	£	1	9 6

This would be the cost of laying on the water for ordinary domestic purposes. The water-closet branch would be an additional expense, the amount of which would depend entirely upon the arrangement of the premises. If the closets were erected in private back yards, one to each house, this additional expense would probably stand thus:—

	£.	s.	d.
Fourteen feet of $\frac{1}{2}$ -inch branch pipe = $37\frac{1}{2}$ lbs., at 3d.	0	9	4
Cast-iron service-box, with apparatus for pre- vention of waste.	0	15	0
Two solder joints and labour	0	2	0
Opening and closing the ground and fixing pipe and apparatus	0	5	0
	<hr/>		
	£1	11	4

If the closet be used in common by the occupants of more than one tenement, this amount must be divided by the number of tenements to which it is made to pertain. A Water Company, if authorized by Act of Parliament and secured in the possession of its property by the substitution of the check of supervision in lieu of the check of competition, would be glad to provide and maintain both the foregoing apparatus for a weekly charge of $1\frac{1}{2}d.$ per tenement exclusive of the charge for the delivery of water to the *house and closet* on the principle of *constant supply*.

Supposing numbers done, and on contract, what would be the expense of laying down such apparatus on old tenements of the poorer class? Would 1*l.* extra for old tenements, above the general expense of laying down such an apparatus, be an under estimate in most provincial towns?—No; because in all the old districts of provincial towns the arrangement of the houses is so imperfect, that one closet must usually suffice for more than one family.

Would the expense of the whole apparatus, when laid down in the simplest manner, exceed 5*l.* if done on a large scale?—It would not. The total expense would, I think, be about four guineas in the majority of cases, and especially so if this kind of work became, as it very properly would, a distinct occupation.

And hence a considerable saving would be effected on the existing charge for cleansing the cesspools properly; would that be so?—Yes, beside effecting the perfect and immediate removal of much offensive and disease-generating matter, and so promoting the health and energy of the working classes. My own observation and inquiry convince me that the character and habits of a working family are more depressed and deteriorated by the defects of their habitations than by the greatest pecuniary

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privations to which they are subject. The most cleanly and orderly female will invariably despond and relax her exertions under the influence of filth, damp, and stench, and at length ceasing to make further effort, probably sink into a dirty, noisy, discontented, and perhaps gin-drinking drab—the wife of a man who has no comfort in his house, the parent of children whose home is the street or the gaol. The moral and physical improvements certain to result from the introduction of water and water-closets into the houses of the working classes are far beyond the pecuniary advantages, however considerable these may, under certain circumstances, appear.

You consider that the private drains should be closed and impermeable either to water or gas?—Yes; and there is another advantage that is apt to be overlooked—that if the drains be properly constructed, rats and other vermin will be effectually excluded from the house-drains or dwellings.

Will it not be an advantage to the tenant, and necessary for any general system of cleansing, that the house-drains should be constructed under a general regulation, and executed, wherever the owner chooses, under a general contract?—Yes; it would be advantageous to the public. For private drains to be efficient, they require nearly the same amount of skill and attention in respect to falls, curved junctions, and general arrangement, as is required in laying down water or gas-pipes. All under-ground work is apt to be carelessly and badly done, for the defects, however serious, are buried with the materials.

To avoid this peculiar disadvantage, it has been proposed that the general contract under which all the branch drains, as well as the main drains, are made, should be not merely to make, but to maintain them in order for a certain time; thus giving the contractor a motive to make good works at first?—This, if found practicable, would be decidedly beneficial, especially if the works were executed under the control of a competent officer, having no interest in the contract.

It is presumed that you consider that special general arrangements would be requisite in respect to the trapping of all house-drains for the prevention of the transmission of smells and unwholesome effluvia?—Yes.

Do you consider that the sewers of towns may be improved in general construction, and rendered more economical?—Yes; by the use of egg-shaped sewers, built with radiating bricks. I find an egg-shaped sewer, 2 feet 9 inches high, and 2 feet wide, may be laid at a depth of at least 8 feet for about 3s. per foot, the bricks radiating, and the rim $4\frac{1}{2}$ inches thick. Such a sewer will be large enough for two-thirds of the streets of a provincial town, if the inclination be not less than 1 inch in 10 feet. Such a sewer would frequently drain 500 or 600

houses, and would relatively answer the purpose of second-sized (4 feet 6 inches by 2 feet 6 inches) sewers in London. Staffordshire drain pipes of 10 inches diameter would answer for most courts.

Are there sufficient data at present to reduce a system of sewage to rules, for their arrangement and the determination of the capacity requisite for drains and sewers to convey the water of a given district?—Yes; I have paid great attention to this department of the science of hydraulics, and have arrived at laws which I believe are generally applicable.

Will you have the goodness to furnish these results in a paper prepared at your leisure?—I shall be ready to do so.

May it be confidently stated that the application of science to the construction of the drains and sewers of most towns would lead to reductions of the common expense, as well as improvements in efficiency?—Yes; for drainage works now require frequent alterations and amendment, in consequence of the want of due knowledge and the deficiency of foresight of the variable and unskilled bodies on whom the management now devolves. Any competent officer, acting under general instructions, and possessing scientific knowledge on these points, might save much money, and at the same time effect great improvements. Drainage works are too commonly considered to be insusceptible of improvement by the application of scientific principles, and hence fall into the hands of tradesmen or other parties quite incompetent to design or execute the work in an efficient way, and in the few instances in which such works are conducted by competent men, such men are commonly controlled and directed by persons totally incapable of exercising a sound discretion on the subject.

It is presumed that you consider that there ought to be no untrapped gully-holes opening from the sewer into the streets?—This is imperatively necessary for the preservation of the public health.

As you improve your sewerage by these arrangements, and carry off the elements of food contained in it, much of which is now employed in manure, have you considered any method of rendering the sewerage available for horticultural and agricultural purposes?—I have turned my mind to that subject. In some cases it will be very easy to receive the sewer water of a town into depositing tanks, and there to collect the subsiding matters. With respect to the application of liquid manure containing much valuable matter, perhaps greater difficulties may arise, especially in such towns as are not favourably situated; for although the water may be pumped to a distance for the use of the lands, and may be applied to the purposes of market gardeners, this can only be effected to a limited

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extent. The principal difficulty arises from the very large quantity of water thrown into the sewers by steam-engines and manufactories, and it is on this account, principally, that I am induced to entertain great doubt of the practicability of the scheme.

Do you not think that a system of pumping the liquid manure from towns might be carried into effect?—I have afforded to the Commission some data from which the expense may be estimated. It is quite clear that a very great weight of liquid material may be moved by pumping more cheaply than by any other known mode of conveyance.

Have you made any calculations as to the cost of conveyance of a certain quantity of liquid from the sewers of the town for any given distance?—Yes; the cost of transmitting water to a distance is very trifling indeed. Distance is scarcely any element in the expense of the conveyance through pipes; in fact, the pipe is a sort of continuous cart, which it is not necessary to move. You put the water into motion at one end, and whatever force you apply at that end is transmitted, minus the friction, to the other. You have not to carry the weight of the cart or of the horse with you, and therefore the cost of removing water to a distance by means of pipes is very trivial indeed.

Could not provision be made for allowing the great bulk of the rain-water to pass into subsiding tanks?—Yes; I think it desirable that the water should be passed through such subsiding tanks (supposing more than one, for I prefer more than one, and see many advantages in there being more than one, even though the area may not be increased), depositing the solid matter and then going over a weir; but in many towns a large quantity of sand is borne down by the rain, and when that comes down it would be desirable that the water should not be passed through the tanks at all, but take another course.

Now, since the hand-labour and cartage of the two loads, to empty the cesspool or privy, has to be performed, whether in country or town, will not the saving be equally effected by a system of removal in suspension in water, to catch-pits or receptacles in the country, whence the manure may be sold to the farmer when deposited, minus the labour of emptying the privy and the cartage to and from the town?—The cost of transmitting water to a distance of five miles, and to a height of 200 feet, including wear and tear of pumping machinery, fuel, labour, interest of capital invested in pipes, reservoirs, engines, &c., amounts to about $2\frac{1}{2}d.$ per ton. The cost of cartage to the same distance and height will, under favourable circumstances, amount to $4s.$ per ton. The quantity of water annually consumed by one individual amounts to about 20 tons, and the refuse produced is usually estimated at about 1 ton;

consequently, 21 tons of liquid manure must be transported in place of 1 ton of solid manure; and hence it appears that the expenses of conveyance to a distance of five miles in the liquid and solid states would be almost precisely equal. The liquid manure would, however, be available as an irrigant, and produce vastly greater effects than the solid manure, of which much of the most valuable components is dissipated in the atmosphere. In the neighbourhood of Edinburgh, where sewer-water is applied as a manure, four or more crops are yearly obtained. It is questionable whether the *deposited* manure would alone be of much value, inasmuch as the soluble salts would be retained by the water. The main objection to the execution of this project would, I apprehend, arise from the difficulty of preventing the admixture of the waste water of steam-engines with the ordinary sewer-water. If a town of 50,000 inhabitants have dispersed over it a number of condensing engines of only 500-horse power in the aggregate, the waste water will amount to at least 1500 gallons per minute, while the house sewer-water will not exceed 1200 gallons per minute. I do not see the same difficulty with respect to rain, for the sewer-water may then be excluded from the reservoirs, or be allowed to flow through them and deposit the insoluble matters in its course.

You have stated that the main difficulty attending the pumping of the sewage water out of a town for application in agriculture arises from the admixture of the waste water of steam-engines with the sewer water?—I have.

Now it is stated in evidence that in those parts of the metropolis where such water is allowed to run into the sewers, the emanations from the sewers are additionally offensive and probably additionally injurious, it being explained that the additional heat facilitates decomposition, and the steam or moisture diffuses it?—We have had instances of a like nature in Nottingham. At the bottom of St. James's-street, and at the corner of Bridlesmith-gate the effluvium emanating from the sewer water has been most offensive, and has been the occasion of frequent observation and complaint. The introduction of a good system of "trapping" would remove the evil.

As an instance of the effect of heat and moisture combined in producing injurious effects, it is mentioned that the persons who remove the clothes from the fever patients and carry those clothes from the Hospital are never known to catch fever, whilst the persons who wash them are rarely known to escape?—All elastic fluids are most efficient articles of vaporizable matter. It is now more than suspected that the matter of infection is in its physical properties very analogous to some of the hydro-carbons, which though nearly fixed at and below

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a certain temperature become rapidly volatilized and absorbed on the addition of a few degrees of heat to the air or other elastic fluid with which they may be in contact. It is probable that a large quantity of "febrine" may in this way be conveyed into direct communication with the blood in its passage through the lungs of a washerwoman and so produce the effect alluded to. The emanation from heated sewer water is physically similar to but is much more heavily loaded with noxious matter than the steam of a wash-house.

Inasmuch as by the general principles of legislation and of local administrative policy all the excreta of a town belong to the public, and their modes of removal and useful application are matters of public policy, would it not be an easy and proper arrangement to require all such water to be carried away in some small separate drain, as a one-foot tube-drain? — Unless the waste water after being collected could be usefully and profitably applied there would, I think, be some difficulty on the score of expense, especially if the cost which might in some instances amount to a couple of hundred pounds or more were made to fall upon the owner of the engine. This, in fact, would be to impose a penalty on existing manufacturing enterprizes, which I think very undesirable; but I do not object to the introduction of any alteration of existing arrangements, providing such alterations be effected at the public expense. Upon a further consideration of the subject, I am, however, disposed to think a separation of the waters would not in general be needful. On the system of constant supply the quantity of water annually delivered to a town of 50,000 inhabitants, and for the most part returned by the sewers, is—

Inhab.	Gal.	Days.	
50,000	× 20	× 365.	. . . . . = 365,000,000 gallons,

and the water from steam-engines of the aggregate power of 500 horses would at most amount to—

Horses.	Gal.	Min.	Hours.	Days.	
500	× 4	× 60	× 12	× 300	. . . . . = 432,000,000 gallons.

Making a total of 797,000,000 gallons.

Now this is only equal to the quantity of rain which falls in the course of a year upon 820 acres of land, and would amount to an average daily depth of the twelfth part of an inch upon that extent of surface. A town of the magnitude instanced requires much more than this quantity of land for the production of the various descriptions of fruit and vegetable crops, and reasoning upon the ascertained advantages derived by the gardeners at Edinburgh from their very imperfect applications

of sewer water would be greatly benefited by the contemplated arrangements, although obtained at an annual cost to the cultivators of the soil of perhaps 3*l.* per acre for mains, works, and management, and 1*l.* or 2*l.* per acre for the distributary apparatus situated within the private grounds.

Are you not aware that large public tepid baths have been formed in London with the waste water of steam engines?—Yes, and that there is a similar application of engine water at Nottingham.

What extent of public baths, and at what heat would such 500-horse steam engine supply?—The water would suffice to bathe 26,000 persons per diem. The temperature might be as high as from 92° to 110° if taken from the hot well of the engine, and as low as from 60° to 80° if taken from the waste pipe. The temperature of the waste water of different engines varies very considerably, the average is probably 70° or 75°.

What size of public wash-houses, such as are in successful use at Liverpool, would such waste water supply?—Larger than would be required to wash for a whole county.

What do you do with the waste water of your own steam engines?—Return it to the river. Some years ago it was thought that this water might be made available for a public bath to be placed without the Company's works, but a prudent apprehension existing that the public might dislike the notion of a bathing-house so near the Company's reservoir, the "scheme," though useful and practicable, was abandoned.

For the application to agricultural production of such liquid refuse as a town affords for manure, would not such a mode as that by water-pipes and jets at high pressure have advantages, in respect to rapidity and cheapness of distribution, over the common mode by irrigation, and by water meadows, especially for market gardens in the vicinity of towns?—I think so; for the grasses of agriculture are not naturally the production of submerged grounds, and though undoubtedly benefited by temporary immergence under water containing fertilizing agents, would obviously be much more benefited by a distribution of such water unaccompanied by submergence.

Have you hitherto considered the subject with a view to any practical application?—Some years ago I proposed to a landed proprietor to raise water by steam power from a brook, for distribution over a farm of about 300 acres; the estimated expense was about 3000*l.*, but it was not considered necessary in this case to introduce so many lines of pipes as I should now be disposed to recommend, especially in the case of valuable lands in the vicinity of towns.

Specimens of six-inch and four-inch strong earthen pipes have been produced to the Commission which have only yielded

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at a pressure of a head of water of 900 feet, 300 feet being the proof pressure to which iron pipes for the supply of towns are exposed; supposing that these strong clay tubes bear an equal continuous pressure, will they not only have the advantage of being two-thirds cheaper than iron, but of being incorrosive? — They will not be two-thirds cheaper, because the expenses of laying them will not be diminished. They will certainly not corrode by oxidation, but iron pipes kept constantly filled are not subject to any considerable or injurious corrosion.

In respect to the advantageous consolidation of the duties of paid officers in reference to new public works where scientific superintendence is needed, Mr. *Thorp*, the surveyor of Hull, is asked:—

“ Q. Suppose an officer of proper qualifications were required to devote his whole time to the public service, do you, judging from your own experience, see any difficulty in one officer, (after such works as those contemplated for the relief of a town were in action,) as a responsible officer of public works, superintending the general house and street drainage, and road drainage and cleansing, and supplies of water, and seeing to the execution of the provisions of a Building Act in respect to proper drainage, levels, and ventilation?—A. One officer might, I think, do it in general. Here the corporation have a property in houses and farms, producing a rental of upwards of 10,000*l.* a-year, and the corporation surveyor could not now do it without assistance. In most towns, with proper assistance, one officer might accomplish the work very well. If the drainage and supplies of water are carried out as parts of one system, they would without doubt be the best carried out under one authority. In laying and taking up water pipes I should find it of great inconvenience if I had not the control of the pavements. In the Dock Company’s grounds, where I have no authority over the pavements, it has occasioned delay and obstruction to the public works.”

You manage the gas-works as well as the water-works of Nottingham, do you not, besides attending to your other professional business?—Yes, I do.

Does your own experience corroborate the conclusion that, in order to obtain the services of officers competent from scientific qualifications to conduct such works economically; in order also to avoid the clashing, delay, and want of adaptation of arrangements that must be combined to obtain the same end efficiently—the local works for the supplies of water, the drainage of the town, the drainage, care, and cleansing of the roads may be advantageously and economically consolidated under the superintendence of one engineer, or officer of scientific qualifications?—Yes; in localities entirely new to these objects, I think one such officer may advantageously control such works; and in localities where the works are already established, those under the public control may be advantageously consolidated; but the management of the concerns of private or incorporated companies, whose works have

been constructed with private capital, would possibly not admit of easy consolidation with that of bodies who have constructed their works from funds raised by public rates. There can, however, be no doubt that the mutual interests of the public and these companies would be promoted and secured by the establishment of a competent authority instituted by Parliament, for the purpose of exercising due control and supervision.

What do you consider, either as to a new or an old district which may stand in need of improvement, in respect to supplies of water or general drainage, would be the first practical step to be taken?—In respect to drainage, it will in many instances be found that, owing to the neglect of the natural water-courses, the waters of the district are very imperfectly carried away: this is particularly the case in flat and marshy districts; and along the course of considerable streams, sometimes obstructions, both natural and artificial, occur at distances considerably removed from the place intended to be improved. It will therefore be necessary to institute a searching survey, and to construct a comprehensive plan for the purpose of ascertaining and determining the nature and extent of those improvements which may be deemed necessary to promote the health and comfort of the population that are to be affected. Such survey and plan would also materially contribute to the efficiency of construction and the economy of management. The extent of survey must be determined by the natural features of the country, and must not be limited by any artificial boundaries. Hence it is manifest that such survey, however originated, should not be left to the management and discretion of parties having limited and conflicting interests, but should be conducted by some distant and disinterested authority, to which neither the rural nor the urban district population could offer any valid objection. Such a survey would necessarily be first directed to the examination of the principal river upon which the drainage of the district depended, with a view to ascertain whether any impediments of a removeable nature existed in or upon such river. In case no impediments were found, it would then next be necessary to examine all the outfalls of the brooks and minor streams, and to pursue these, levelling in the direction opposite to that in which the water flows, for the purpose of determining the various rates of inclination and other circumstances which may have an influence on the discharge of the water from the locality. It will then be seen what improvements, by deepening or otherwise, may be necessary to the open streams to give effect to the system of sewers that may afterwards be introduced. Previously to designing new sewers or improving old ones, it will be necessary to continue the levels from the rivers, brooks,

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and streams into and along all streets and highways within the natural area, and to note with great particularity what quantity of water is now or may hereafter be transmitted from portions of the country situated beyond the immediate limits of the survey and from those places to which the town is most likely to extend. It would be necessary to make provision not merely for the ordinary amount of water, but to have particular regard to the removal of the extraordinary falls of water on the occurrence of heavy storms, by which it frequently happens that the houses of the labouring classes, situated in the lowest parts of manufacturing towns, are inundated, and are so rendered for long periods both uncomfortable and insalubrious. Such a survey would govern and determine the alterations and additions to the existing house and street drainage, and the levels for the repavement and improvement of the road and streets. Such a survey would also be useful for the better distribution of gas and water. In consequence of the want of a survey and the independent action of different local bodies, or of successive members of the same bodies, great injury is done to existing property, and much doubt arises with respect to the proper position of new buildings. Thus it frequently happens that after a street has been laid out and built upon, and sewers formed, and gas and water-pipes laid and pavements put down, that a part of such arrangements will be found or deemed by a subsequent authority unsuitable or inefficient. The surface of the street will therefore, perhaps, be arbitrarily altered, raising or lowering the ground two or three feet above or below the door-ways of the houses, and burying deeper or exposing and necessitating the removal of gas or water-pipes. I have known houses rendered nearly inaccessible by such alterations; I have known instances in which water-pipes, laid at proper depths of three feet deep, have been brought by the lowering of the road so close under the pavement, that the pipes have been broken by passing carriages. Pipes have also been buried six feet deep by the raising of the road. Such disturbances occur in the oldest parts of towns, where it might have been reasonably concluded that no alterations would be necessary. I do not mean to convey that such alterations were not really sometimes improvements of the roads; but that the great sacrifice attending such alterations might have been avoided had the works been originally formed on a proper survey, and under the supervision of a competent and permanent authority. In the formation of new districts, such a survey would govern the direction of the drainage, and thence the direction and final formation of streets; and would determine the levels of the floors of the houses both with reference to the drains and the pavement. In suburban districts property is now much injured by being, without any purpose and in entire ignorance, placed

above and below proper road-way and drainage levels. This state of neglect, from want of information, interferes with comfort, health, and ultimate economy. Straggling houses are built, perhaps along the side of an undulating or irregular suburban road, one house up and one down; intermediate houses are afterwards gradually added; and at the end of some years the street, thus irregularly formed, at last receives the attention of the parish authorities, who proceed to make such alterations as may then suit their own peculiar and perchance ill-founded notions.

Would it not be an advantage to the builders, that, before laying down the foundation of any new building, its essential relations to drainage and levels should be predetermined, and that on going to the engineer or officer of works of a district in whose charge such survey should be left, and upon giving such engineer the ground-plan of the building, he (the builder) should be entitled to, and have afforded to him, all the levels, inclines, and forms of drainage necessary for his information and guidance?—Yes; it would be advantageous to the builder, and of essential service to the public; and I may here add that it appears to me very desirable that the plan to be made upon the survey already mentioned should have lines of contour or equal altitude distinctly marked thereon, that the best and most economical arrangement might be at once selected.

Supposing, in new districts, the appointment of one competent officer having superintendence of the works for drainage and supplies of water, and the care of the roads, being in possession for such works of the public survey, having to visit and examine new building sites and new streets, to see that the drains were being perfectly laid; might he not be charged with the duty of seeing that party walls were properly constructed, and that other provisions incident to an Improvement Act were duly complied with?—I think the imposition of this duty would occasion little additional trouble, and that it would afford the further advantage that a builder would have only one officer to consult instead of many.

Should you think that a survey of 60 inches to a mile would be ample for all the purposes of drainage and increase of towns, and most other matters?—Yes; but I think it might be desirable to have in a book some parts on a larger scale for very particular purposes.

With respect to contour lines, what should you consider generally a useful difference in the vertical distance of the contour lines from each other?—On national maps it would be sufficient to mark every 10 or 20 feet on district maps; the difference ought never to exceed five feet. In some cases, where towns are flat, it may be desirable to mark every second foot, or even every single foot. In towns the bench marks, to

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be of general service, should not be more than 100 yards apart.

Would you not think it desirable that bench marks should be inserted in public buildings, supposing such a survey to be carried out, in order that the levels might be always connected with an uniform datum level?—Not only on public buildings but on all private buildings where they might appear useful, as, for instance, at the corners and in the bends of streets. Such marks would be exceedingly useful in laying down pavements in streets, in determining the inclinations of the sewers, in laying and proportioning the magnitude of gas and water-pipes, in determining the heights of the floors of houses, and for a great many other purposes of a public character. I have found, in the course of business, the greatest inconvenience to result from the absence of such a datum. I conceive, also, that these marks would be of some importance in a sanatory point of view, inasmuch as they would enable the influence of elevation to be taken into account. They would likewise serve to check and regulate the construction of all public works, for it happens now sometimes that in laying a sewer the builder will commit a great error, and the work has to be taken up and done over again. Now, if those bench marks existed at short distances, the operation of boning* would in such a case be substituted for that of levelling, and the operation of boning a workman may perform with accuracy who would be totally incapable of performing the more difficult operation of levelling.

Then the bench marks would not merely serve for the guidance of the masters and the superintendents of works, but also for the guidance of the workmen themselves in the course of their common works?—They would. The workmen's instructions would be referred to the bench marks. The bench marks would also supply a great amount of useful information to public Boards, who could then judge in many instances with nearly the same accuracy with which a surveyor or engineer could judge. They would afford constant information, and save numerous repetitions of surveys.

It is your opinion that it would ultimately save expense to the town, the bench marks having been once established?—Certainly.

Do you see any ground for believing that the construction of detached houses may be promoted, as a better and not more expensive security against the spread of fires, than the erection of party walls between each dwelling?—In general it would be cheaper, and almost invariably more beneficial to leave an unoccupied plot of ground of the width of a house at the end of every eighth, tenth, or twelfth dwelling of a street; such a

* For an explanation of this mode of levelling, see the evidence of Mr. Dean, p. 428.

measure would not only prevent the lateral spread of destructive fires, but would secure a free ventilation of the interiors of squares, or blocks of buildings which are now little better than cisterns of stagnant air contaminated by every source of exhalation.

Would a space to every eighth house suffice?—Yes, I think it would; the distance between these spaces might in general be regulated by the class of houses on a due consideration of all the circumstances affecting the health and condition of the inhabitants.

Would not the extra expense of eight or ten party-walls in general exceed the value of the land required for the space?—In general it would; particularly in provincial towns and new neighbourhoods.

From your practice or observation, in respect to the construction of tenements in the provincial towns, do you deem legislative protection necessary as to the sorts and sufficiency of materials, so as to ensure the stability of tenements or edifices of any kind?—I think that legislation on these points would have the effect rather of preventing improvement than otherwise, by restricting invention and the use of new materials. I would carefully avoid an excess of legislation, and prefer giving general discretionary powers to a competent authority.

This arrangement, then, would, besides effectually preventing the lateral spread of fires, secure a greatly improved ventilation within and amongst the buildings?—Yes, it would do this, and in many cases afford double frontages for shops and other buildings requiring a large quantity of light. I state this more with a view to the regulation of the sites of houses in new districts than with a view to any alteration of buildings in old districts.

Are there any party walls to the tenements of the working classes at Nottingham?—No; the dividing walls are very rarely more than four inches and a half in thickness.

Do fires ever occur in buildings of this class?—Very rarely, practically never.

Then practically there would appear to be no need of party walls in respect to this class of dwellings, at the least for the prevention of fire?—I think not.

What would be the additional expense of a party wall to this class of dwellings?—Generally about 5*l.* per house.

What proportion does that bear to the whole cost of the house?—About one-twelfth.

What additional rent occasion?—About two-pence per week.

That is to say, as much as would pay for insuring a loss of 200*l.* (including the duty) and double the expense of affording

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a supply of water, instantaneously applicable to the extinction of any fire, night as well as day, and diminishing the necessity of insurance itself?—Yes, certainly.

In respect to the higher class of dwellings, have you observed any case for legislative interposition to ensure the building of party walls at Nottingham or other towns for which there is now no Building Act?—No, I have observed no amount of evil to compensate for the expense. The gross expense of party walls would almost everywhere be greater than the amount of capital requisite for supplying it with water.

You have now examined the different rates of mortality incident to different states of the internal and external ventilation of houses; to the different states of atmospheric impurity occasioned by the defective arrangements for the internal cleansing of their houses and the defective arrangements for the cleansing and drainage of the streets and land in the vicinity of houses: to what extent do you consider it practicable to reduce the mortality prevalent amongst the labouring classes by measures within public administrative control?—To the extent of 20 per cent. most certainly, and by the same means promote their comfort, happiness, intelligence, and pecuniary interests.

Has not your attention been called to the defects of the existing arrangements for obtaining supplies of water, and for effecting drainage and other local improvements attendant on the present mode of procedure for obtaining powers to effect such objects by private or local Acts of Parliament?—In the course of practice as an engineer, my attention has been unavoidably drawn to this subject.

Are not many small places excluded from the benefits obtained by larger places, by the great cost of procuring an Act of Parliament?—Yes; the expense of procuring an Act of Parliament operates to prevent many useful works of small size from being executed. I have known small water-works and gas-works to be established without the authority of Parliament, and for as little as would have been the cost of obtaining the power. Of course this was done at considerable hazard, for no protection is now afforded to works so established. In some instances the place has gradually grown, and the works have ultimately afforded the appearance of profit. A competitor has then stepped in, and by obtaining an Act of Parliament, greatly injured the first adventurers. Hence arises a reluctance to invest money in works which are too small to bear the expense of an Act of Parliament, and yet too costly to be constructed without one.

In these cases are not two capitals and two establishments imposed on a field that might be well supplied by one?—Yes.

Does not this also occur when the first company was established by Act of Parliament?—Yes, frequently.

What is the operation of this introduction of a second company?—Usually injurious to the interests of the proprietors and of the public.

State upon what you ground that opinion?—Two capitals become invested; two sources of wear and tear are created; two managements, and two complete sets of officers must be maintained; two causes of loss and leakage are established; for all which the public must and do ultimately pay as well as for the enormously expensive conflict to obtain the Act of Parliament, and for the rivalry and strife of several subsequent years. It may be mentioned that in some districts of London, three, four, or five companies have pipes, and are occupied in performing the service which might be quite as effectually rendered by one, and perhaps by that one, under proper supervision, at half the cost of the present supply. These companies seldom continue in *active* competition for long periods. Finding the competition ruinous, they coalesce openly, or enter into a private understanding, by which the public are deprived of the benefits of the supposed competition. The charges are either increased or remain fixed much above those at which a single company would willingly supply. It may be affirmed that the metropolis might, under proper arrangements, be efficiently supplied with gas at 5s. per thousand feet, instead of at the 8s. or 9s. now charged, and yet the companies are in general ill remunerated for the capital they have invested, and the risk they have encountered, and this evil arises solely from the great amount of capital brought into the field to encourage competition, and to satisfy the complaints against a monopoly which exists only in consequence of the omission of Parliament to subject single companies to a supervising authority competent to afford an equal protection to the interests of the public and of such companies.

Then if the metropolis were supplied with gas under one management, might the gas be sold at 5s. per thousand cubic feet, and yet afford a fair rate of remuneration upon the investment?—It undoubtedly might; at Manchester, with one concern, the charge for gas in 1842 was 5s. 2d. per thousand cubic feet delivered; while in Liverpool, with two companies, it was 6s. 2d.; but notwithstanding the 1s. difference in price, and a smaller manufacture, Manchester was enabled to apply to the improvement of the town, and in increase of assets, as much as the two 10 per cent. dividends of the Liverpool companies,—thus showing that two companies will cost the public 20 per cent. more than one company. Another remarkable instance is that of Glasgow, which being at present supplied by one company, the public are charged only 1s. 3¼d. per

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thousand feet in payment of dividends, whereas in Liverpool, where there are two companies, the public are necessarily charged 2s. 5½d. per thousand feet for the payment of dividends.

Can you state that the same circumstances are applicable to the supplies of water to the public?—Yes, they are more or less applicable to all rival establishments working with a superfluous capital, which is for the most part irremoveable. Second companies would, in general, be wholly unnecessary, but for original defects in the system of legislation. In nearly all cases the objects sought to be obtained by the introduction of rival companies would be infinitely better obtained through the agency of an authority instituted for the double purpose of enforcing the compliance of the original companies with the provisions of the Acts under which they are established, and of protecting them from the aggressions of interested parties and of capitalists stimulated to the conflict by the hope of pecuniary gain. For example, in the case of Liverpool there are two capitals employed in supplying the town with water on the old system. I believe it would be found that one of these Companies could, with but small additions to its means, supply the whole of the water required for public purposes had there been any authority to interfere and adjust equitably the additional charge to be made for the extended supply. But the usual mode of intervention was in this case resorted to. A third capital of 100,000*l.* has been introduced to effect purposes which might have been obtained at probably one-third the expense. This additional capital has been raised for the attainment of a nearly single object, viz., the extinction of fire, and will entail a lasting tax and an annual expenditure of large amount upon the inhabitants. Moreover, the machinery being intended for only very occasional use is less likely to be maintained in perfect order and readiness than machinery required for constant service.

Then you consider that great injury is done to the public as well as to the companies by the want of an intermediate procedure, and means of inquiry and control by some superior authority?—Yes. I may further illustrate this want by the case of the city of Glasgow, in respect to its gas-works. That city was supplied by one Company, which, as its consumption of gas and its works extended, went on reducing its charges. The quality of its gas was proved and admitted to be excellent, the price very reasonable, and the manufacturing power more than sufficient. But its supposed prosperity excited the cupidity of another body of speculators, who, hoping that they might share the extending field of supply, made application for a private Act. The diminished and diminishing price was incontrovertible; but the Company had refused to supply con-

sumers during the day, on the ground that the expense of a day supply to the few consumers requiring it, would, from the leakage of the extensive system of pipes to be kept charged for that purpose, be wholly disproportionate to the return. This, along with other minor allegations, was thought to justify the resolution that the preamble of the Bill was proved, and that a further supply to the city was needed. Now the consequence was this, that a further capital of 150,000*l.* or more has been driven into a field where it is almost entirely superfluous. The interest of all this capital must and will be charged on the public within the field where it is obtruded; by the introduction of this other Company, the cost of the gas will be increased or kept up at least 1*s.* 8*d.* per 1000 cubic feet, even although the consumption of gas should increase so much as 30 per cent. This will, of course, constitute a permanent tax in whatever form it may arise. The old Company will find it impossible to go on with their reductions of price with the increased consumption, because the manufacture will be divided. Whereas, if there had been a properly constituted Board in London, to whom an appeal might have been made on the question of the day supply to the consumers, that Board would have caused a local examination by some competent and impartial public officer, who would perhaps have reported that the Company's reasons against the day's supply, and against the other allegations, were insufficient. This determination the Company must have obeyed, and the additional supply would have been given; and instead of an increased and permanent charge, if the whole supply had remained to be given from one Company, there would have ensued a saving of at least 4*d.* per 1000 feet from the further extension of manufacture, making ultimately a difference to the public of at least 2*s.* per 1000 feet on all the gas sold, after allowing for the dividends on such small additional capital as it would have become needful to invest.

Can you afford any instances of the public advantages resulting from the extension of such manufacture and supply?—Yes. A very complete instance is afforded by the progress of the Glasgow Gas Company: in consequence of a triple extension of manufacture, the quantity of gas supplied for a given sum was increased about 35 per cent., and the expenses of management were greatly diminished. I will put in this printed statement (*vide Appendix*, p. 98), which I consider a further exemplification of the principle already expounded in relation to Water Companies.

Amongst other inconveniences of having several irremovable capitals or sets of machinery for the same description of supply, does not it occur that the pipes get intermixed, and the supplies of one company are taken from the pipes of the

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other?—It does, and in some instances pipes have become so united that the mains of one company have been partially fed at the expense of the other company. In this case the company whose works afford the greatest pressure is the sufferer, and may be ruined by the goodness of its supply. Some competing Gas Companies, as well as Water Companies, have been most severely injured by occurrences of this nature.

Do you believe that Companies having the supply of water as well as gas would in general be willing to submit to superior regulations and control, and even relinquish their prospects of any increase of revenue beyond the legal interest on capital invested for the sake of obtaining by such submission security for their property, and the great additional value which that security would confer?—I believe all respectable Companies would be glad to submit their works and interests to the regulation and control of a properly authorized and competent authority, who should judge and determine between themselves and the public. But I do not think it would be just or proper to reduce the dividends of such Companies to the ordinary rate of 5 per cent., which I understand to be implied by the term legal interest. Many Companies have encountered great risks, and have foregone their dividends for many years, and though now actually receiving more than common interest on the nominal value of their shares, are really deriving, under all the circumstances, only a very moderate profit upon the investment. It should also be borne in mind that shares are transferable, and, as such, attain the value due to the risk and prospect of the Companies, rather than that value which would represent the present condition of the Companies. I am, however, quite certain that, if public Companies were placed under the protection of a national authority, instituted for the purpose of enforcing compliance with Acts of Parliament, and acting as arbiters between the public and the Companies, great good would result; and that the Companies, being freed from the risk of injury by rash speculators and local agitation, would in general make larger investments, afford a more extended supply, and be willing to receive something less than the rate of dividends authorized by their Acts of Incorporation in return for the greater security of their property.

Will you have the goodness to state by what form of local administration the measures which you deem most important to the health and comfort of the population may be the best carried out?—The statement of my observations and views on this very important subject would require more care and detail than it is possible for me to attempt in a verbal examination. I take the opportunity, however, of stating, that I think it would be injurious to invest any local body with new powers of expenditure without the means of supervision and regula-

tion by a competent superior authority, to protect and promote the true interests of the community. It is impossible that common local authorities, subject to all local interests and influences, could conduct such an important business with any proper degree of efficiency, foresight, and economy. There is already not only a mischievous division and petty hostility amongst different local bodies, but strong and direct interests against improvements, to overlook which would be completely fatal to any plan of local remedies. In Nottingham, for instance, I have repeatedly heard the owners of the small houses in the most crowded, unhealthy, and altogether worst conditioned districts, warmly object to the enclosure of the commonable or lammas lands, using such terms as these: "If those lands are enclosed and built upon, our houses will be emptied." In other words, the working classes of that town are compelled to submit to a positive diminution of life resulting from confinement in an unhealthy, uncomfortable, and, in some respects, demoralizing situation, for the supposed benefit of this class of proprietors. I say supposed, for a large amount of loss of rent, as well as of an increased amount of local taxation falling on the owners and expended in relief, is undoubtedly occasioned by the bad and crowded condition of the dwellings which the working classes are thus under the necessity of occupying.

Does this class of persons obtain local influence in the decision of such questions?—To a very great extent.

As the land in the centres of the towns would always be more valuable for commercial and first-class buildings than any outskirt land, may it not be presumed they must be ultimately gainers, and certainly not losers, by the change; and would not the benefits derivable to themselves from improvements be capable of demonstration?—They are not likely to be persuaded of that; for although I have no doubt they would be gainers, yet in general they are more influenced by their apprehensions of immediate loss than by their hopes of future gain.

Then are not the occupiers of these houses alive to the importance of electing independent and intelligent persons to represent their interests on the local Boards?—Quite the contrary. A party agitation, generally of a political character, is got up, by which the real merits of the question at issue are effectually obscured.

May it not, however, be stated that the charges of new improvements being frequently levied at once on the owner, who is defined to be the person in receipt of the immediate rents or profits, are frequently objectionable, for want of fair distribution, and thus inflict injustice, even if the works themselves were of undeniable advantage?—It is almost of daily occurrence, undoubtedly, that the immediate pressure of the pecu-

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niary burthens imposed by local improvements has the effect of depriving for a time the owner whose property is in mortgage, of the whole residue of rent after payment of the interest on the mortgage.

Would not such of these objections as are just be obviated by the distribution of the repayment of the investment over a sufficiently long period?—Yes; for the works are generally of a durable character, if the repayment do not extend over a considerable period, the burthen of the permanent improvement will, in many instances, have to be borne by parties possessing only limited interests.

Would not such arrangements remove opposition?—To some extent it might abate it. But the objections are always made to assume a party character, and give party advantages. The cry, which would not be abandoned, is always raised, “Why, it is the Black Party, or the White Party, who are moving this; they only want to tax you; vote for us, and we will protect you!” Under the influence of feelings thus excited, the working classes almost invariably act in direct opposition to their real interests.

Where there are no properly qualified persons for the management of such works, do you think the risks of mismanagement so great that they would on the whole be undertaken as cheaply by private companies?—As against the ordinary municipal management, which is of a very expensive and variable character, and one which never assumes a commercial character, I am quite certain that even in their present shape supplies by joint-stock companies are better and cheaper. The direction which in companies is thought to require some experience and qualification, is thought in the bodies adverted to to require neither.

With regard to the purposes of health, how do you consider that Acts of Parliament should best be prepared?—Considered solely with reference to health, I am not prepared to give an immediate opinion. I can give an opinion how they should, in my judgment, be prepared generally, and I apprehend there would be little difference in the mere circumstances. I conceive that, after an Act shall be proposed to be obtained to effect any local purpose, then that, before it shall be promoted in the House of Parliament, a competent Commission should issue (rather from an established central authority than directly from Parliament), and always as a matter of course, and that the whole scheme should be investigated by inquiry and inspection on the spot as to its necessity and its perfect efficiency; that such Commission should prepare a report; that upon that report being prepared, a Bill should be drawn according to some regular rule, and by the officers of the central authority; that after the Bill has been so drawn, the local bodies interested

in the measure should have an opportunity of inserting in it any clauses they might wish to meet their own special views, and that those clauses which met their views, but did not meet the views of the central authority, should be printed in italics; that the Bill in that state should go before the House of Commons, along with the report; and that the Commissioners should have an opportunity of being heard before the Committee upon it. I conceive such a measure as that would obviate a great amount of defective legislation. In consequence of the want of special investigation on the spot, legislation by private acts is generally carried on in the dark; and the legislature does not know, and cannot know what extent of powers it grants, or to what persons, and how wastefully or oppressively those powers may be exercised. The worst and most inequitable provisions in private Acts are usually to be found in the Acts obtained by corporations, and other bodies, having the command of the public purse. Any minority, or, indeed, any majority, or any private individual, affected by and opposing these Acts, can only do so at their own private expense, which is generally so extreme as to be ruinous or prohibitory. The projects of public bodies are always therefore to be looked upon with suspicion, and require the most close preliminary and disinterested investigation conducted on the spot, as to the propriety, efficiency, economy, and equity of the measure proposed.

Do not you think that would also entail considerable delay? —No; I think there is quite sufficient time between the period at which, under the existing standing orders, the notices are given in the newspapers and the time at which the Bill is brought before a Committee of the House of Commons, to investigate the whole question; and I think that its subsequent progress through Parliament would be greatly facilitated; that needless Bills would not be presented, and that useful measures would not be opposed.

Such local examination would, you consider, include a plan founded on a survey—in the case of water-works, for example? —In all cases in which works are to be established, whether for water-works, drainage, or for any other purpose, it appears to me essential that there should be, not only a special plan of the proposed works, but also a general public plan of the entire district plan, and that evidence should be taken before the Commissioners sent down; nor, indeed, could any due investigation be made, unless it was based on a plan then already prepared.

Do you consider that the present mode of giving notices of private Bills is sufficient for the protection of the interests of the great mass of the occupied population or the interests of any except those who may have pecuniary or rival interests to

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be interfered with?—The notices contain next to no information beyond the mention of the locality to which the proposed Bill is to apply; they convey no information as to the details, but merely that it is intended to introduce a Bill in the next session of Parliament to effect certain purposes in certain places.

Would not an examination by a competent authority very frequently serve not only to protect the parties investing their capital, but also to protect the interests of third parties, namely, the public at large, as well as reversioners, from having their interest prejudiced by a scheme pushed forward with one-sided views?—It would have that effect undoubtedly, and would promote uniformity of legislation, which is a very important and a very neglected object.

Would such an examination of a proposal to supply water to a town be so far expensive as for that to be a serious objection on the ground of expense, or would it not in point of fact save the expense of litigation, and save resistance by parties who would yield to a compulsory constant authority what they would never yield to on the part of those who were immediately and directly interested in carrying out the plan?—Undoubtedly.

You think that such a survey, and a report upon it, would be a matter of economy?—Yes; I think a survey applying to the district would be most valuable as the basis on which all subsequent devices and works could be formed, and that that survey itself would very materially diminish the difficulties and expense of preparing the plans for any subsequent objects.

If the report on the plan and survey were published, and were accessible to the population of the districts, and if it stood in coincidence with the charges of execution, and the benefit to be obtained by the amount each individual will have to expend, would not that greatly tend to popularize and facilitate works of that kind?—Yes, it would, and it would allay local and party agitation on the subject, which is frequently highly injurious.

The useless expenditure about private Bills, which ends in some privileges being obtained, but at a great cost, is somehow or other extracted from the public?—Undoubtedly it is an addition to the capital of the Company, for there is introduced a clause into every private Act, by which the Company incorporated is enabled to treat it as capital, and to pay a dividend upon it.

Anything that could simplify the obtaining powers from Parliament, either by a general Act or by separate Acts well considered, will have the effect of cheapening the cost of those measures to the public?—No doubt, but it would

be very difficult to have a general enactment for those objects; there are so many interests to be provided for, I think the application of the powers given in a general Act must necessarily or almost always be aided and accompanied by a private Act, to vary them and enlarge them, and multiply them.

You object to a general Act without a central authority, but not to a general Act with a central authority, having power to regulate?—I see little difficulty in a general Act with a central authority. Special circumstances may even then occasionally arise in which additional powers will be required.

Suppose a general power carried out with the view you take, and the provisions of it to be in some measure under the direction of a central authority with reference to the public health, do you not think that one great deficiency, namely, the want of water in many large towns, the difficulty and expense of obtaining an Act being removed, would be supplied by individuals or Companies who would be ready to invest capital for such purposes?—No, not as to large towns; but I think as to small towns it would. There is now no difficulty in obtaining Companies in large towns.

Would it not afford a facility which does not exist, without getting a separate Act in each case, if persons were enabled to join together for the purpose of supplying water for a town, or any other purpose of that kind?—I think that it would; but such a power would be very objectionable unless the means of efficient supervision and control by an authority perfectly independent of all local influences were at the same time provided.

Do not you think that a great field for the investment of British capital might be opened, by reasonable legislation, to give facilities for the supply of water?—Yes, and I think if adequate powers were given, and the fear of competition removed, a great amount of capital would be invested in that and other analogous undertakings; but the insecurity of the present mode of investment, from the danger of the introduction of competing Companies, generally does interfere with the application of capital to those purposes.

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APPENDIX.

Illustration of the Saving to the Public from extended Manufacture of Gas under one Establishment.

TABLE of the *actual saving* to the Inhabitants of Glasgow, between the Years 1830 and 1842, resulting from the extension of the Manufacture and Operations of the one existing Gas Company, from the Books of the Company, by Mr. Hawksley.

Triennial periods.	Increase of Manufacture compared with the periods 1828, 1829, 1830.	Absolute Saving effected in the successive Triennial periods, being the actual reduction in the Consumer's payments for the quantity supplied.	Diminution in the amount of Dividends with which each 1000 feet of Gas was charged in the years 1828, 1829, 1830.	Diminution in amount of Salaries with which each 1000 feet of Gas was charged in the years 1828, 1829, 1830.	Diminution in the amount of Wages with which each 1000 feet of Gas was charged in the years 1828, 1829, 1830.	Remarks.
1831-32-33	25 per Cent.	£10,958	17 $\frac{6}{10}$ per Cent.	9 per Cent.	8 $\frac{4}{10}$ per Cent.	. . . . At the latter end of this period additional Works were brought into operation under the same management to meet increased consumption.
1834-35-36	66 $\frac{2}{10}$ per Cent.	£31,854	20 $\frac{8}{10}$ per Cent.	23 $\frac{1}{2}$ per Cent.	20 $\frac{6}{10}$ per Cent.	
1837-38-39	116 $\frac{6}{10}$ per Cent.	£56,769	49 $\frac{4}{10}$ per Cent.	34 $\frac{7}{10}$ per Cent.	19 $\frac{3}{10}$ per Cent.	. . . . In this Triennial period Meters were more generally applied, which by diminishing illicit consumption increased the profits 5 <i>d.</i> per 1000 feet; they, together with the further profits arising from the extension of the Manufacture, enabled the Company to make a further reduction of 1 <i>s.</i> per 1000 feet.
1840-41-42	136 $\frac{3}{10}$ per Cent.	£50,045	52 per Cent.	37 $\frac{8}{10}$ per Cent.	25 per Cent.	
Final saving to the Public.		£149,626 On the whole 12 years.	52 per Cent. <i>per Annum</i> at the present period.	37 $\frac{8}{10}$ per Cent. <i>per Annum</i> at the present period.	25 per Cent. <i>per Annum</i> at the present period.	Further increase of manufacture will occasion <i>further reductions</i> , by spreading the stationary expenses over larger quantities.

THOMAS ASHTON, Esq., examined.

T. Ashton, Esq.

ARE you a manufacturer at Hyde, near Manchester?—Yes.

How many labourers' houses have you there?—About 320.

Have you introduced water into these houses?—Yes, into every house. I was at the expense of putting down the tenants' communication-pipe; the total cost was about 1*l.* per tenement. I charge them 1*s.* per annum rent for this tap, which is included in the rent of the water, which is 3*d.* per week, and is charged by me for this convenience. I pay it quarterly to the Water Company.

What was the state of things before you had water laid on? In what way was the water procured?—They had to fetch it from various wells and places in the neighbourhood. They had also tubs to collect rain-water for washing; these tubs were continually leaking. The labour and annoyance of fetching the water was excessive. They fetched it in cans. The wells were the continual source of demoralization.

Has the change of practice given satisfaction to your tenants?—Very great, indeed. I know no alteration that has given so much; there is never any complaint in paying for the water. They say they save money by it; that the saving in cans and tubs, which were continually broken, would almost pay the expense.

Have you observed the effects on their domestic habits?—Their houses are much cleaner, especially their back yards. The tap is placed over the sink in the kitchen; it is always at hand, and occupies no space; and there is no stint in the use of the water. On some occasions, when there was a long drought, the water was shut off by the manager for fear of its being all used before another supply came; but on such occasions of intermittent supply it is found that more water is used, than when it is on constantly. When it was let on occasionally, for fear of inconvenience they filled all their pans that they might not be straightened; they drew consequently twice as much as they used. When the water came in again they threw away the water that was unused and took a fresh supply.

From your experience, have you any doubt that where water can be procured that a compulsory measure for laying it on in the houses is advisable, and preferable to any measure of supply by stand-cocks?—Wherever the water can be had, I have no doubt of the propriety of a compulsory measure for laying on water in the houses. In our neighbourhood the introduction of the water into the houses of the labouring classes is proceeding voluntarily. They tried the system of supply by stand-pipes, which has been very generally abandoned.

Then even at 3*d.* a-week, which is deemed to be double the expense of a practicable supply introduced into the house in other places, the improved supply is considered an economy by the work-

T. Ashton, Esq.

ing classes?——It is, in fact, an economy. For a family of six or eight persons the labour of fetching water for washing and culinary and domestic purposes was very great. There were formerly water-carriers. The poor people used to pay a penny per day for the smallest families; some of them paid 1s. a-week, and were in no degree so well supplied as at present. Besides the expense of fetching water, they had formerly the expense of their rain-water-tubs and pipes. Their condition has certainly been raised by an increased supply of water, more attention is paid to cleanliness, personal and household. The regulation of the supply of water is undoubtedly a matter of national importance.

You say you have introduced the water into every house; do you mean even the most humble habitation?——Yes.

What is the smallest rent paid by such houses?——About 18d. a-week.

Have you noticed any effect on the health?——Yes, very great, indeed; cleanliness has always a tendency to health, and they are much more cleanly.

You consider that their health has decidedly improved?——Certainly.

As compared to their condition previously?——Yes; they admit that themselves.

How long has this been in operation?——About seven years from the water being introduced to the completion, but it is about two years since the whole was completed.

Have you not found that where the houses belong to very small proprietors they are very unwilling to pay the charge for their tenants?——Certainly.

Will, therefore, some plan by which a water-rate could be put on the owners of small tenements where the rent is secured weekly or at short intervals be highly desirable?——That is very advisable, because many will not put it on themselves, and the landlord will not.

You think that some plan is desirable by which the owners of small tenements, where the rent is received either weekly or monthly from those very poor people, should be compelled to pay?——Certainly; but under some restrictions upon the Company with respect to the size of the dwellings.

Do you not think that the same observation applies to the payment for water as to other small payments of that kind?——Certainly.

Does not your experience in the populous district in which you live show that their not being obliged to do so is a very great hinderance to the improvement of many of those poorer districts?——Certainly.

WILLIAM CHADWELL MYLNE, Esq., C.E., examined.

W. C. Mylne,
Esq., C.E.,

ARE you a civil engineer?—Yes.

Your father built Blackfriars Bridge, and was engineer to the New River Waterworks; did you succeed him in the latter capacity?—Yes.

Besides conducting those works, have you not been extensively engaged as an engineer on drainage and other works, and been consulted with respect to the supplies of water in different parts of this country and abroad?—Yes, I have.

The New River Company, we understand, is the oldest system of waterworks in the metropolis; will you have the goodness to describe, briefly, the original state of the supply in the metropolis, the origin of the New River Company, the progress of its works, its extension, and any late improvements that may have been made under your direction in the mode of supply to meet the public demand?—The general supply of London has increased as the wants of the inhabitants. Originally they appear to have been supplied by the numerous excellent wells that were found in it, such as Holywell, Clerkenwell, Clementswell, and others; also from the running waters of the bournes, such as Langbourne and Shirebourne. These being insufficient, the next means of supply were by *conduits*, such as the *White Conduit*, from Islington, Lamb's Conduit, and many others. These conduits were supplied by leaden pipes, which arranged the water for distribution. The inhabitants of London were thence supplied, as the people of Paris now are, by water-carriers. Several of the conduits were destroyed by the Fire of London. A private individual, Peter Morrice, a Dutchman, erected the first waterworks for raising water from the Thames, and laid the foundation of that establishment, which, under the name of the London Waterworks, continued until they were removed with the Old London Bridge, when the establishment was transferred by an Act of Parliament to the New River Company, to which the supply of the city of London was transferred. The supply by the New River was the enterprize of Sir Hugh Middleton, commenced in the year 1609, and completed in 1613. The supply is from the springs of Chadwell and Amwell, with additional supply out of the Lea, near Chadwell in Hertfordshire, which is about 20 miles from London in direct distance; but the course of the river is nearly 39 miles. The distribution of water by the old conduits I have stated was in lead. Up to the commencement of the present century the supplies by all the Companies were by wooden pipes of elm. The New River Company had at that time 400 miles of wooden pipe. About the year 1809 the use of water-closets became very general among the better description of houses. The distribution of the water was then to the lower floors. The water was forced up by force-pumps to supply the tanks for the water-closets. New

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Companies were then projected to supply the water at a higher pressure, and, by the use of steam power, through iron pipes to force the water up to the higher stories, which could not be done with the wooden pipes. Iron pipes were then generally introduced, and the high service adopted. During the operation of completing their works in iron, the Company removed or abandoned about 20 miles of wood pipe per annum. The bore of the wooden mains were from six to seven inches, and of the service-pipes three inches. The streets were relieved by the substitution of large iron mains. The principal mains now vary from 12 to 30 inches; the sub-mains are seven and six inches, with services generally of four inches. By the increased diameter of the pipes, the friction of the distribution is now very materially reduced.

Between the distribution in wood or iron, were there any differences experienced affecting the quality of the water?—Not any material difference ultimately. At first a chalybeate effect was noticed, and I now dress the interior of the pipe with a preparation of lime-water, which prevents any inconvenience from being felt. The introduction of iron pipes had been attempted by engineers for a long time previously to the general introduction; but the pipes were then screwed together by flanch joints, which allowed of no contraction or expansion: they were, therefore, broken by the temperature of the water, producing a variation in their length; they became defective in summer and winter, according to the variations of the temperature of the water introduced. The pipes were as thus laid down in the New Road, one rod of iron two miles in length. They broke at various lengths, commencing with half miles, quarter miles, and then into breakages of about 100 yards each. This difficulty was overcome by the general introduction of the cylindrical socket joints, on pipes laid down in lengths of nine feet, which allow of a compensating contraction and expansion, which contraction, however, is so small that no inconvenience is felt even in those lengths where the turned cone joints are in use at Manchester. With these joints, which must be turned accurately, no stuffing is required; only a little whiting and tallow is used, and the joints are at once formed, and the pipes driven up. The use of packing and lead, and the pilfering of lead, is thus wholly avoided. I have used this joint for the suction-pipe of a steam-engine, 30 inches in diameter, which answers perfectly. Formerly the tenants' communication-pipes were introduced into the wooden service-pipes, and afterwards into the iron service-pipes by ferrules of brass, which commonly projected into the interior of the pipe, and obstructed the passage of the water. I believe that these ferrules, which are very liable to be loosened by the different contraction of the metals, are still used by some companies. I now unite all the tenants' communication-pipes by flanch joints, the pipes being cast with flanches for that purpose. Before this change was effected, during bad

weather or the breaking up of a frost, 20 or 30 tenants' communication-pipes were blown out in a week. Formerly all the cross branches, when the distribution was by wooden pipes, were at right angles. When iron was introduced, I took care to have them all curved; this made a considerable difference in respect to friction. Formerly the pipes were apt to be broken by the sudden closing of valve-cocks—by the introduction of the screw-cocks, which the men can only shut gradually. This inconvenience and loss is avoided, and in the case of supplies at high pressure, is absolutely necessary. The improvement as to the quality of water has been effected by increasing the capacity of the reservoirs from one day's to seven days' consumption. We have since that time turned much rain water, which came into the water from the land surface, under the river. Then, where there is grass land adjoining, we have fenced off the river to prevent cattle getting into it.

What is the quantity of water at present distributed by the New River Company?—The average annual quantity of water supplied by the New River Works for the last three years has been 614,087,768 cubic feet. Deducting from this the larger consumers and street-watering, together about 33,529,400, will leave 580,558,368 cubic feet per annum, being equal to $46\frac{1}{2}$ cubic feet per tenement each alternate day.

What is the number of the houses supplied with water by the New River Company?—As near as I have been able to ascertain, about 81,555 tenements.

How many tenements within the district supplied by you are supplied by common cocks?—The number is 4198. They are in course of reduction, and the reduction is encouraged by the Company. I have always considered the system of separate supply the best for the tenant or the public, and also for the Company. I believe the common cocks or stand-pipes are less by one-half what they were ten years ago. Some of these supplies are given into tanks, from which the inhabitants of the courts draw in common; the others are direct from the service. From these latter the water must be taken during the period limited to that supply.

Have you any means of knowing what proportion of the houses within your district have water-closets?—No, we have never kept any account; but we may presume that each house supplied above the ground-floor, of which there are about 21,362, has the supply for the purpose of filling a tank for the water-closet, and if you suppose one-eighth of those served below to have closets, that will make 28,887. I believe that to be so. The use of water-closets is greatly extending, and the applications for the supply at high service is generally for that purpose. The following is a return of the number of houses so supplied as near as I can furnish it:—

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On or below the ground floor, and not more than 6 feet 6 inches high	60,192	} 81,555
„ „ first floor	7,956	
„ „ second floor	7,356	
„ „ third floor	3,772	
„ „ fourth floor	1,689	
„ „ fifth floor and upwards	590	

The Company only carries the mains, the district mains, and the service-pipes, through the streets, and has nothing to do with the tenants' communication-pipes?—No; the Company only lays down iron pipes. The tenants lay down the leaden pipes, but when these leaden pipes are out of repair, the Paving Acts of Parliament require the Water Company to open the ground and see that the repair be completed at the expense of the parties to whom it may belong.

If a court has to be supplied with water, does the Company carry up a pipe?—Yes, it carries iron pipe up all public ground, or that which is under the jurisdiction of the parish authorities.

Were you consulted as an engineer on a plan for supplying Paris with water?—Yes, I was in 1817 and in 1823. I am still engaged upon that subject.

In the plan you have proposed, did it not form a part that the tenants' communication-pipes should be provided and laid down by the Company as an essential part of the works of distribution?—Yes; I considered it the most desirable that it should do so.

Will you state the advantages to the tenant or the public that were proposed from that part of the plans over the common method, leaving every uninformed occupier or owner to the necessity of employing a separate plumber to complete, as he might, that part of the general machinery?—In the first place it would effect a considerable saving of capital; in the next place it would be done on principle and in a superior manner. The trading plumber has no motive to carry out improvements,—two lengths of pipe may be put where one would serve. As an example of the improvement proposed to be introduced in detail, I had intended to introduce lead pipes, with screw joints, similar to those used in wrought-iron pipes. The cost of these joints were not above a penny,—they would have superseded completely the plumber's joint, and neither the plumber nor his irons, fire, ladle, nor labour, were necessary, and an expense of 3s. 6d. per joint was saved. In various respects we should have economized the machinery for distribution.

This portion of the machinery being laid down by the Company, was it proposed to charge at once the expense of this outlay upon the owners or occupiers, or to charge for it a rental?—It was proposed to charge interest on the extra amount of outlay as a rental.

Then these tenants' communication-pipes would have been

under the same general care as the mains or iron pipes of distribution?—Yes, that was my view; and my opinion has always been, that as public traders, that which is best for the public customer is ultimately the best for the Company by whom they are supplied.

What would be the extent of probable advantage to the public in respect to the saving of repairs?—Very great; one public officer would have been appointed to attend to the laying on of all houses, as also to all the repairs. Under ordinary circumstances, when an accident occurs within or without the building, the tenant has to think how it is to be repaired, and has to consider how he is to pay for it, and who is to be sent for; the plumber, when he arrives, makes the repairs in his own way, which is without reference to any general system. Two-thirds of the labour, on the occurrence of any accident, is in the journeys which would be rendered unnecessary under a general system, by which, on such an occurrence, the inconvenience may be remedied at once. The advantage of having the tenants' communication-pipes placed under one general system, would have been, that they would have been so laid down at first, as to have avoided many of the incidental injuries which they are liable to from frost and accidental circumstances, as well as being placed where they could readily be repaired.

In the case of a Company undertaking to lay down these pipes, would not the repair of them form part of the general charge, and be added to the rent?—Yes; frequently an accident occurs towards the end of the tenant's term of occupation in the premises, and the cost of repairing it may be equal to his quarter's rent. Being a tenant at will, or near the termination of his lease, he says, I may be turned out shortly; it is not worth my while to undertake it, and it is left undone, if within his premises.

Increased dilapidation must be the consequence?—Of course, that naturally results.

In that plan, then, you assumed as a principle that the tenants must be relieved of the immediate outlay, and the expense be spread over a period and collected as a rent?—Yes, certainly. This was the more necessary at Paris where the dwellings are extensively occupied in flats (as at Edinburgh and Glasgow, and in several other towns) as distinct tenements. Each flat would be held for various periods, some of the nature of tenancies at will, some of them of the nature of leasehold, and under every description of interest and period of occupation. Of course, the parties having short intervals would not undertake the immediate expense of the outlay for the permanent improvement, nor would the persons in the lower apartments pay for the repairs in any lower part of the building necessary for the supply of any upper apartment.

Did the plan of comprehending the tenants' communication-pipes, and the whole machinery under one general system, offer

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any advantages in respect to economy and sufficiency in laying down the iron pipes?—In a new town there would often be much public economy in laying pipes on both sides, instead of in the centre of the streets,—there would be the saving of lead pipes, the saving of repairs to these lead pipes, the avoidance of the inconvenience and expense of breaking up the roads for that purpose,—the saving of the inconvenience to the tenants in the event of frosts, from there being less of their smaller pipes being exposed. In a street of 60 feet wide, the saving of lead pipe would be about 20 feet to each tenant; that is, if the street is built upon each side, there would be 40 feet of leaden pipe saved in a house frontage of say 20 feet, therefore 20 feet of iron extra would avoid the use of 40 feet of lead.

In carrying the water up the higher houses, would you not have introduced iron pipes?—We should have introduced iron wherever we could. At that time, when lead was very dear, I contemplated the use of tinned copper pipes.

How many water-carriers were there in Paris in 1823?—The number of people thus occupied in Paris was 1400.

What was the charge for carrying water?—Their rate of charge is commonly 1*d.* for every six gallons.

What inconveniences were experienced from the water-carriers?—The house is open to them at all hours in the day; they have the opportunity of being in league with the servants, and may therefore convey away the surplus of victuals of the kitchen, and be the bearers of unauthorized correspondence. The public streets are thronged with them, to the great inconvenience of the passengers; and the staircases, also, leading to the several flats, are much inconvenienced by their traffic, and consequent dirt. The public fountains are still worse in their consequences when the domestics are required to attend and convey the supply required for the families.

It appears that in towns in England, which were formerly supplied by stand-pipes, or common cocks in courts, that the distribution of water into the houses has been found to be an economy of two-thirds of the expense of labour of fetching water even immediately from the door: that by the application of capital and machinery in the distribution of water by a Company, or under scientific arrangements, the labour of pumping, where spring water and the pump is to be had gratis, is rendered expensive?—Yes; this has always worked out in practice. At Colchester, I remember that almost every house had a good pump and well, when the waterworks were first executed; few received the water at first, and my opinion was required upon what was supposed to be a defect in the work. My advice was to wait patiently for the repairs of the pumps. They did so, and in about seven years the majority of the town received the water, and I believe now all the respectable houses are supplied.

Do you, as an engineer, recognize the application of the principle of the cheapening by one general machinery; the labour of supplying a town with water, to the saving of hand labour and cartage in cleansing or removing the *excreta* of a town, by applying the principle of removing, under one general system all such *excreta* in suspension in water?—I have no question as to the theory,—I have always applied it in practice to the cleansing of reservoirs, &c., and in mill rivers. It is practised throughout the kingdom, wherever the substance is at all capable of being put in suspension in water. The power of putting and maintaining substances in suspension depends greatly on the velocity of the stream.

If you had been enabled to carry the water into the houses in Paris, would it have led to the general application of the water-closet system as a means of cleansing?—Decidedly so; the houses were already prepared for the introduction of the system, and it was much wished for by the inhabitants; and sewers were then being constructed in all parts of the city.

Then the completion of the system, or combining cleansing with a system of supplying water by machinery, would have led to the supercession of the labour of the body of *vidangeurs*, or nightmen and scavengers, as well as of the labour of the *porteurs d'eau*?—Decidedly; it would not only have superseded the labours of the *vidangeurs*, but the nuisance of their labours, which every one who has passed through the streets at Paris at the night will be well aware of. It is indisputable that water is the best and cheapest means of removing all decomposing matters. Nothing improves the habits so much, nothing civilizes a population so much, as improvements in the modes of removing the excreta of the population. I know scarcely anything so demoralizing and degrading as the common privies to various courts in towns, and to clusters of cottages in villages. For this reason, wherever I could recommend it to be done, I have abolished them; and I conceive that there should not only be separate accommodation for each house, but, when possible, separate accommodation for males and females of all classes.

In digging to lay down the water-pipes in the metropolis, is any inconvenience sustained by the workmen from the soakage of the cesspools?—No; our pipes are generally laid above the levels of the basement floors, below which cesspools are generally made, but very serious inconvenience is sustained by the gas getting into the water-pipes.

Is that a frequent occurrence?—Yes; very frequent, where there are competing Companies. I believe the joints of the gas-pipes are very badly made. The whole of the earth of some of the streets in which the pipes are laid is so charged with gases, that within the boxes of the fire-plugs, if they are covered over in the evening, the vapour collected in the twelve hours will ignite in the morning. Our services have been so frequently found charged that complaints

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are continually being made of gas being carried by them into the houses together with the water. In several instances explosions have taken place, to the injury of the persons carrying down a light. Instances have occurred where, lights being applied to our water-pipes, the gas has ignited, as if the pipe were a gas-pipe. I have no doubt that houses are fired by these escapes. A short time since a sewer exploded, from the accumulated gas having been accidentally ignited, in Rosamond-street, Clerkenwell. It may be smelt issuing from the ground. When inconvenience is first discovered, the pipes have been left charged with water; thus the entrance of the gas into the pipes is prevented from being drawn in by the suction of the water, as the pipes empty themselves on the service-cocks being closed. This indraught of the gas has been corrected by the application when required, of a stand-pipe against the front of the houses, on the top of which is placed a valve to prevent the discharge of water, but open to the discharge of gas. The evil has been the subject of the great complaint in the places named in the following returns:—

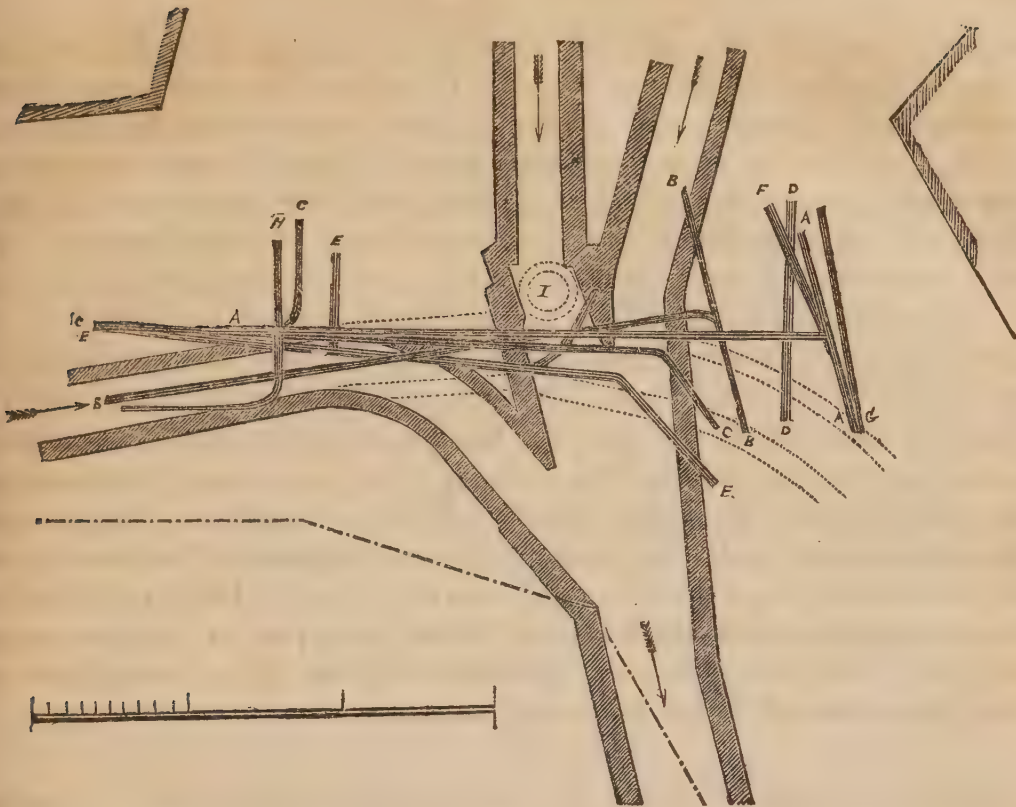
Localities in which Services have been found charged with Gas during the last three years.

High-street, St. Giles's	C. E. L.	V. Sutton-street, Soho	C. E.
V. Holborn	C. E. L.	V. Great Queen-street	C. E.
V. Holborn	C. E. L.	Moor-street, St. Giles's	C. E. L.
V. Holborn	C. E. L.	Dean-street, Soho	C. E.
V. Strand	C. E. L.	V. Judd-street, New Road	L. I.
Strand	C. E. L.	Keppel-street	I.
Strand	C. E. L.	Rosoman-street	C.
Crown-street, Soho	C. E. L.		

C. denotes that the *Chartered Gas Company* have mains and services in the locality.
 E. " *Equitable Gas Company* " "
 L. " *London Gas Company* " "
 I. " *Imperial Gas Company* " "

Cases in which the evil has been remedied by a stand-pipe and an "escape-valve" have V. prefixed. In other cases cause of complaint has been removed by the stoppage of leakage in gas-pipes, &c. At present the West Middlesex Water Company are redriving in Tottenham Court-road, with the view of getting rid of the same nuisance.

The annexed wood-cut shows the number and intricacy of the water and gas-pipes at Upper St. Martin's-lane, where the alteration now being made in the line of sewer has afforded an opportunity of obtaining the specimen:—



- A belongs to Chartered Gas Company, 4 inches diameter.
- B belongs to Equitable Gas Company, 6 inches diameter.
- C belongs to London Gas Company, 6 inches diameter.
- D belongs to Equitable Gas Company, 8 inches diameter.
- E belongs to London Gas Company, 12 inches diameter.
- F belongs to New River Water Company, 10 inches diameter.
- G belongs to New River Water Company, 6 inches diameter.
- H belongs to New River Water Company, 5 inches diameter.
- I is the man-hole for entering the sewer.

The dotted lines mark the old sewer in the centre of the former street. The other line shows the old lines of the houses.

Have you also heard complaints of the gas finding its way into the sewers?—The inconvenience, as well as the danger of explosion arising from accumulations of gas in the sewers, has caused the officers of the Westminster sewers to make use of the Davy Lamp as a protection against such accidents. The following is the report of their officers on the subject in 1841 :—

SEWERS OF WESTMINSTER, AND PART OF MIDDLESEX.

Experiments with the Davy Lamp in Examination, &c., of Sewers.

*Sewers' Office for Westminster, &c.,
15th March, 1844.*

In accordance with the direction of the Court of the 2nd of February last, we beg to report the particulars of the experiments made by us, in conjunction with Mr. Farthing of the Chartered Gas Works, as to the applicability of the improved Davy Lamp to the duties of the workmen and officers of this Court, and as a precautionary measure against the frequent explosions of gas collected in the sewers.

On February 3rd, we made an examination of some sewers in Bloomsbury. Entering from Woburn Street, we passed into Woburn Court,

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Duke Street, Castle Street, Museum Street, and Great Russell Street: and returned by the same route to Woburn Court, having been occupied about an hour.

On February 7th, from the Guard Room at Buckingham Palace, we passed through the line of sewers leading under James Street, Brewer's Green, Artillery Place, and Strutton Ground, to the Horseferry Road outlet at Milbank, the inspection having in this instance occupied an hour and seven minutes.

Again, on February 17th, entering the sewer in Tottenham Court Road, opposite Francis Street, we passed into Drury Lane, Queen Street, Wild Street, Vere Street, and by Saint Clement's Church into Norfolk Street, in the Strand. On this occasion we were an hour and five minutes.

And on February 27th, in our examination of the sewer from Park Lane through Upper Grosvenor Street, Grosvenor Square, and Lower Grosvenor Street, we were occupied nearly three hours.

In these four experiments there was no perceptible diminution in the light of the lamps, of which we had three, and as far as we could judge was perfectly adequate to any purpose required in our investigations, either as regards measurements or the necessary memoranda.

It ought also to be remarked, that in the sewer leading from Castle Street to Museum Street, there is a drop in the levels of about four feet, which compelled us to pass upon our hands and knees, and in other parts so low and obstructed as necessarily to cause much motion of the lamp, without, however, perceptibly affecting either the steadiness or brilliancy of the flame. Moreover in the experiments in Westminster, for a considerable portion of the distance, the water and silt were knee-deep, and from the unavoidable splashing (by which the lamp at times was entirely covered), it would have been impossible to have preserved for any length of time a light less efficiently protected.

During the first day's examination, we were not sensible of the presence of any gas, but in the others it *was exceedingly perceptible*, particularly under Strutton Ground, Westminster, Tottenham Court Road, Monmouth Street, and the west side of Grosvenor Square, *so much so as in some measure to affect the respiration*, and without doubt had the flame of our lamps been exposed to its action, *an explosion would have been inevitable*: for instance, in the sewer on the west side of Grosvenor Square, which was exceedingly low, *the gas was ignited within the wire shade of one of the lamps, but without producing any effect beyond that of immediately extinguishing the light*. There was also during some portion of the route in the third experiment, in the neighbourhood of Messrs. Meux's Brewery, and adjoining the Distillery in Vine Street, a considerable quantity of steam, but it had no material effect upon the light.

As evidence, however, of the degree of protection afforded by the Davy Lamp, we would instance the result of some experiments subsequently witnessed by us at the Chartered Gas Company's Works, in the Horseferry Road, in which the flame of the lamp was subjected to a strong pressure of carburetted hydrogen gas, without causing the ignition of any portion of the jet outside of the wire shade, the effect being similar to that before noticed, viz., that when the gas had filled the interior of the lamp, the flame was immediately enlarged, and (from the expulsion

of the oxygen) became gradually reduced, and was finally, extinguished: a state, be it observed, which would hardly occur in practice, without previously indicating its own danger, as it implies a condition of atmosphere where the respiration would be much impeded, and in fact scarcely compatible for any length of time with animal existence.

It would appear, therefore, that where there is a liability to explosion from the presence of carburetted hydrogen, or other cause, the Improved Davy Lamp affords an almost certain protection.

For practical purposes, as regards any required operations in the sewers, its light under general conditions would be sufficiently powerful, and at the same time free from the liability of being extinguished by any accidental circumstance.

We would, therefore, respectfully submit to the Court the propriety of generally adopting the Davy Lamp, in all cases connected with sewer examination, which, if not a perfect, is at least the most effectual security we possess against the recurrence of those accidents so recently in our recollection.

GEORGE HAWKINS, *Assistant Surveyor.*

ROBERT JENKINS, *Clerk of the Works.*

Is there not at Paris a survey, with all the levels laid down in contour lines of equal altitude?—Yes, there is; and I found it extremely useful in laying out the plan for the distribution of the water in levels.

Is there any such survey for the British metropolis, or for any of the British towns where you have been consulted as an engineer?—Not any.

What is the consequence of this want?—That the public are put to the expense of an imperfect survey for every special purpose. I have known the public expense of a survey incurred by each of the engineers in three different consultations for the drainage of the same tract of land. We are compelled to have surveys or levels taken for the distribution of water.

Then they have to be taken for laying down sewers, for laying down gas-pipes, and for roads where any engineering skill happens to be applied to them?—Yes; it is so.

For laying down water the surveys taken usually give only the longitudinal sections?—Yes.

So that if there be any deviation to one side or the other, there is no means of knowing from these sections whether it is into a pit or on to a hill?—Not from the survey.

But with the survey with the contour lines marked thereon you see at once?—Yes, you have the levels of the whole face of the country before you.

If there had not been a complete set of levels at Paris, marked by contour lines, what would have been the extra expense incurred for estimating the works necessary for the distribution of water?—It would have been the expense of a new survey.

For the cleansing of the metropolis and towns in general, do you not consider that the house drains or channels of cleansing, and the

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main drains or sewers, ought to form parts of the same system laid down under the same general arrangements, carried out under the same general authority, comprehending within its jurisdiction the whole of the natural area or jurisdiction for drainage?—If this were so, the general drainage would be efficient and economical. In respect to house drainage, for example—if it were laid down under one general plan, with authority to enforce it, the house-drains from the kitchens and the drains of the water-closets, which are invariably at the *back of the houses*, instead of being carried underneath the floor and through to the front of every house, would probably be carried into a barrel-drain running through back garden or yards. This barrel-drain might carry away the whole of the sewage into a distant main sewer. Independently of the pecuniary economy, there would be great advantage to the public in respect to the purity of the air in the houses. Under such a system, the escapes of liquid and of gases into the dwelling-houses would be avoided. However well the house-drains are trapped, there will be escapes at times.

Then you are of opinion that, on a general system, the expense of sewers may be generally reduced?—Yes, as regards the minor branches.

On the general application of the principle of flushing in the sewers where the declivity is insufficient, and to house cleansing by the introduction of water-closets, you contemplate considerable modifications in the system of sewerage to increase its efficiency for the immediate and rapid removal of all substances subject to decomposition?—Certainly I do.

You recognize the principle, that the body of water should be as little diffused or spread in the sewer or drain as possible, that it may have the least friction, and act the most powerfully, and consequently that the bottom of the drains should be small rather than large?—The figure of the bottom of the drain should be such as to keep as near as possible the same velocity in the current, by which the matter is held in suspension; so that when the quantity passing be reduced one half, the extent of retarding surface presented to the current should be proportionally reduced with the diminished cross sectional area occupied by the passing liquid.

Have you ever had to consider or try the advantage of a system of ventilation of sewers by chimneys?—Yes; having often been inconvenienced by the effluvia arising from apertures in sewers, I have in such cases applied high vertical shafts in the nearest situation to the sewer, and have found them to answer the purpose completely. Such shaft being communicated by a sufficiently large orifice, the vapour, which travels in the opposite direction to the water, will at all times ascend by such an aperture into the shaft, by which it will be conveyed (under the pressure of the atmosphere) above the level of the house. I have always found

this efficient, and consider such a shaft, when *masked* as a column, or obelisk, might be erected with effect on the higher extremities of every sewer in the squares or open spaces.

Would lines of drainage, preappointed upon a well-considered survey, be advantageous in governing the width and directions of streets?—I do not see how it would assist in determining the width of streets; but before laying out any district for building, a survey for the drainage is absolutely necessary, the result of which must govern the directions of the proposed streets; their width, I conceive, will depend more on the nature of the atmosphere of the *locality* under consideration; the ventilation of the town also, as regards the natural operation of the wind upon it, is material; the prevalence of the westerly winds in Europe generally produce what is termed a *West End* to all large towns, and particularly where much coal is in use.

Are stand-pipes for watering streets in use in your district, or do you consider the use of plugs preferable?—The stand-pipes were in general use formerly, but are not so now, being very liable to be frozen; that which has been substituted resembles a stand-pipe embedded in the ground, with its orifice appearing at the kerb-stone; thus it is out of every person's way, and is protected from frost by the earth surrounding it. The plugs are in use as formerly, and being extremely cheap, have been always adopted by the parishes at whose expense they are maintained.

At what intervals are fire-plugs usually placed?—The distances are various. In the New River Works the average distance is 73 yards on the services, on the mains 157 yards: in all we have about 9000 plugs for the discharge of water upon the street surface. Services will in all situations be found parallel to mains.

What is your experience in respect to the influence of frost on the distribution of water through pipes?—Much will depend on the temperature of the water when received into the pipes; if taken from a deep reservoir it will be many degrees warmer than from a shallow rivulet: the depth, therefore, of the iron pipes should be regulated accordingly, and they should be so laid as to discharge themselves wherever the supply be interrupted. By attending to this, under the customary service supply in London, much inconvenience is avoided, particularly as regards the leaden pipes, which, if laid to empty themselves, will of course never be frozen, but, when laid in an undulating line, will become a solid rod of ice. The wider the streets, the deeper the pipes should be laid, as in all narrow and ill-ventilated courts and alleys frost is seldom sufficiently severe to affect the water.

The Commissioners have received evidence as to the public wants, and especially of the wants of the poorest classes of the population; and as to the practical operation of an extended system of supplies in different towns; from which it appears to be desirable—That the system of supply for the poorer classes of houses by common cocks

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or tanks for several tenements should be superseded by an extended system of supply carried into every separate tenement:—That the system of periodical or intermitted supply should be generally extended to one of constant supply at all times, night and day, and kept on at high pressure, as in several towns and places, so as to supersede the necessity of having, and keeping in good condition water-butts or tanks, so as to be used also early in the morning for cleansing and watering the streets, and at nights to be in immediate readiness on the application of a hose, to be thrown over the house in the event of a fire. Assuming it to be desirable and necessary to meet the public wants in these respects, and carry out such a measure, do you think that the requisite supply could be rendered by the New River Company?—I have no means at present of judging of the extent as to quantity such a mode of supply might require. The population within the district is nearly 900,000 individuals. But there could be no difficulty whatever in increasing at a comparatively inconsiderable distributory expense, the supply of water through the existing works, perhaps even to an extent beyond that which might be required, provided the Company were empowered to take that quantity out of the river Lea, or from the Thames—the latter, however, is subject to much objection as to quality; and at present the quantity from the Lea is limited. Yet it is my opinion that by improvements that might be made in the navigable channel of the river Lea, and by making equitable compensation to the millers where any loss of power might be occasioned, sufficient water of the quality of the New River may be obtained for the public service, and no injury occasioned to the navigation.

Mr. Joseph Quick.

MR. JOSEPH QUICK, examined.

ARE you the engineer of the Southwark Water Company?
—Yes, I am.

Before you were engaged in your present position, what has been your avocation?—I was brought up in the establishment of Messrs. Maudsley, the engineers, and had been about 10 years in the drawing department.

Have you read the evidence of Mr. Hawksley on the subject of supplies of water?—Yes, I have.

Do you concur in opinion that water may be supplied constantly at high pressure?—I concur entirely in the opinion that it is practicable as a question of hydraulics; but it would require special arrangements, incurring expense and outlay of capital for which the Company would need protection. A large proportion of our district, for example, is entirely manufacturing; it is occupied by tanners, fell-mongers, hair-washers, distillers, brewers, hatters, glue-makers, dyers, &c., all of whom use great quantities of water, and most of them have tank

below the level of the street. The consumption of water by these consumers is so great, that we have much difficulty even in giving a supply of 15 or 20 feet high to the private houses in the neighbourhood until the supply of these manufactories has ceased. We cannot supply such places as the hospitals and railways, which require a supply at 60 feet high above the level of the street, without shutting off nearly all the side services and consumers. I agree also in what is stated as to the improved uses to which water supplies are applicable, especially that a system of constant supply laid on for a rental under general arrangements would be very beneficial to the market-gardens and horticultural production in suburban districts like ours.

Mr. Joseph Quick

Would not the special difficulty, in respect to these manufactories, be obviated by providing for them specially a distinct main?—Yes; but extensive alterations would be required to effect that object.

What is the diameter of the main?—Twenty inches.

What additional head or pressure of water would be necessary to effect the delivery in the same time?—About 50 feet.

In the present position of the Company, and of most Companies, must not all such improvements, unless special provision be made for due remuneration by the parties benefited by the change, be paid for out of the dividends or the property of the Company?—Yes, they must; and the Companies have not at present due and proper securities for any such additional outlays.

Have you calculated the expense which would be incurred by the substitution of a system of constant supply, night and day, at high pressure, for the present system of intermittent supply?—Yes, I have.

What would be the addition of the expense incurred per week per tenement for the increased supply within the district supplied by the Southwark Water Company?—Three halfpence weekly, in addition to what they now pay.

Would a large part of this extra expense be saved by the saving of the wear and tear, and the expense of repairing and cleansing water-butts and tanks?—A large proportion; all the expense of renewing, and all the expense of cleansing tanks, would be saved.

How many consumers have you in the Southwark district?—We supply about 18,000 tenants, 4,000 of which are supplied through $\frac{3}{4}$ -inch lead-pipe, 10,000 through $\frac{3}{4}$ -inch pipes with a branch to tenement on each side; about 900 by $\frac{3}{4}$ -inch pipes with three branches to the tenements adjoining; 2,000 by 250 common stand-pipes, and about 1,000 other tenants, whom we call consumers, having manufactories, tanners, fellmongers, hair-washers, glue-makers, curriers, dyers, hatters, brewers,

Mr. Joseph Quick distillers, steam-engines, railway stations, hospitals, &c., which take large supplies.

Within the district, what number of private tenements are there which take no water whatever from any Company?—As near as I can estimate, about 5,000 tenements, containing 30,000 persons.

How are they supplied?—They depend for their supplies on pumps or such rain-water as they catch.

What is the charge for the separate supply to a house occupied by the labouring classes, such as a two-story house?—For two-roomed houses we charge from 5s. to 7s. per annum; for four-roomed houses we charge from 10s. to 14s. We generally charge 3s. 6d. per room, if the occupants pay; or 2s. 10d. if farmed by the landlord. This pays for the expense of collection and the risk of empty houses. Collection by any public body from weekly tenants is impracticable.

In many districts, will not one room be generally occupied by one family?—The poorer districts are dreadfully crowded. In many parts of it there will be more than one family in one room.

Are you led to inspect the tenements so occupied?—When parties apply for a supply of water, it is my business to visit the premises to fix the rate, and to suggest the best means of introducing the supplies; further than that it is not my business to examine.

In what state do you find the poorer tenements?—Dreadfully filthy. There is such a closeness about the passages of the worst places, that I keep as far away from them as I can.

Are they undrained?—Generally. Where they are drained the smell is not so offensive. The state of the drainage, I find, forms the great obstacle to carrying supplies of water into the tenements. We are not partial to the supply by stand-pipes, on account of the trouble they give, of their liability to injuries, and to be out of repair, and to be frozen in winter. They have also other disadvantages, as regards the people themselves. I therefore always advise separate supplies to the houses; at least, to the back yards. The answer generally made by the landlord is, "But we have no drains to carry off the waste. If we have more water brought into the premises, we shall only have more damp, and rot the floors, and make the houses more untenable."

What do you perceive to be the actual state of the main or house drainage in such districts?—Very bad indeed. In the old confined districts, courts and alleys, where the common taps are generally applied for, there are blocks of buildings which have nothing but surface drainage, and which are 200 or 300 yards from any main drain. In the Mint, which is the oldest part of Southwark, the people in many houses throw every-

thing out of the windows into the back yards. In some instances there are actually no privies. If there be any disease prevalent, the seat of it is generally in these places. Mr. Joseph Quick

What is generally the condition of such main drains or sewers as are made ; do they emit offensive smells?—The odours from the gully-holes is very offensive, and in consequence of the land in many places being four or five feet below the level of high-water mark, the sewage, as at present constructed, is sluggish and bad. The effect of the present sewage may be judged of from this instance : Paradise-row, Rotherhithe, had no sewer ; and a new sewer was formed there, as deep as they could make it, to suit the present levels. The first effect was, that it drained the wells, but after the sewer had been some time formed, and had received its accumulations, the water flowed back into the wells but was discoloured, and the inhabitants complained that it was polluted. Application was then made to the Company for supplies of water, which caused me to visit the spot, and by that means I learned the circumstances.

Were there cesspools to the houses adjacent to the line where the new sewer was cut?—Yes ; they being old houses.

The sewer, then, by diluting the matter discharged in it, rendered it more permeable, and saturated the substratum more extensively with it?—Yes, certainly ; the inhabitants themselves ascribed the pollution to the back-water from the sewers.

Have you similar applications in consequence of the pollution of springs and wells?—Yes, we have ; and as houses are built and neighbourhoods become more crowded, the pollution of springs by the permeation of the matter from cesspools becomes greater. They have now got into a mode of deepening the cesspools until they come to the first stratum of sand, six, eight, or ten feet. This cutting generally carries the cesspool into a spring, and relieves the cesspool of the liquid portion of the refuse, which is carried away by the spring into any lower level. The ground, for want of drainage, in some portion of the district, is so saturated with water or liquid, that if a cesspool be emptied one day it will be nearly filled again the next. This observation is not confined to Southwark ; I know it to be the case in several parts of Lambeth.—In the paved and close streets the upper portion of the ground is often blackened and so saturated with the gas as to be extremely offensive to the men who open it.

Do the following statements of the condition of the districts supplied with water by the Southwark Water Company coincide with your own local examination?—

Mr. *W. Stainer*, the Registrar of St. Olave district states, in answer to the question,

“ In what parts of your district has the number of deaths registered in the years 1838, 1839, 1840, 1841, and 1842 been the greatest, in proportion to the population ?

Mr. Joseph Quick

“ In the densely populated courts and alleys where there are open drains and sewers, and the inhabitants are living in dirt, stench, and a state of wretchedness, to be conceived only by those who have witnessed it. Prior to the year 1841 several very unhealthy courts, in which some of the earliest cases of Asiatic cholera occurred on the first appearance of that disease in the metropolis, but these have been removed, and the ground now forms the site of the termini of the Brighton and other railways. There are large open sewers completely stagnant through or near them, the smell from which in summer is so dreadful that it is extraordinary how human beings can bear it. The supply of water is scanty. The inhabitants are not more dirty than might be expected from their circumstances.”

Mr. *G. Pitt*, the Registrar of the Rotherhithe district, states :—

“ Hanover-street contains about 35 or 40 houses in a very old and dilapidated state. The houses have generally six or eight rooms each, and sometimes as many families of the poorest kind, chiefly Irish. As the street has no thoroughfare, and is on an incline of at least 10 feet, it is badly drained. The water and filth constantly remaining in the street, it is most unhealthy. The same remarks apply in all respects to Spread Eagle-court, except that the houses stand on level ground. Norfolk-place and Kenning's-buildings are exposed to the most offensive exhalations of about 150 feet of open sewer, which receives the filth of the whole surrounding neighbourhood.”

Mr. *R. Bell*, the Registrar of the Kent Road district, states :—

“ There are many close filthy courts in this neighbourhood, in these the deaths are uniformly the highest, and the local registration does not correctly show this fact, for the people inhabiting them are very poor, and in extreme illness, are removed either to the workhouse or the hospitals, and they die in those places.”

“ With regard to drainage, the open gutters are choked, and full of water. Supplies of water—good supply from the waterworks. Cleanliness—as a general rule they seldom attend to this, unless they expect a visit from the medical or other officers; they excuse it, by saying they have to work for their living. The people live very close, in small rooms; have often more than one bed in a room. Beds are made of straw and shavings, and a great number sleep on the floor; from three to ten persons in a room; almost every room is a sleeping room.”

The following is the evidence of *Edward Doubleday, Esq.*, Medical Officer of St. Saviour's Union :—

“ What is the state of the sewers for the houses of the poorer classes of the population in your district ?—They are in a dreadful condition. On one side of Broadwall, at the back of the houses, there is an open sewer, into which the privies empty themselves. There is a second open sewer situate between Hatfield-street and Brunswick-street, which extends its course through Brunswick-place; and there is a third open sewer in Boundary-row, all places thickly inhabited. These sewers are the receptacles of all kinds of refuse, such as putrid fish (thrown in by the costermongers living about the New-cut) dead dogs, cats, vege-

tables, &c. These two latter sewers also receive the soil from the privies of the houses situate near them. All the sewers are always offensive, but disgustingly so at particular seasons. Mr. Joseph Quick

“How often are these sewers cleansed out?—Once or twice a-year men are employed to empty them. The Broadwall sewer is flooded occasionally by opening floodgates, and the tide comes in to the others.

“What is their mode of cleansing?—Men with large boots go into the sewers and throw out the filth, and in Boundary-row into the street, and from thence it is carted away, more frequently the mud is thrown upon the sides of the sewers and suffered to remain; opening the floodgates and the tide assist in cleansing. Nevertheless the Broadwall sewer must be considered an open stagnant ditch.

“What is the general state of health of the people exposed to the effluvia from the open sewers?—Low and malignant fevers are much more frequent and fatal in their effects in these localities than in the other low neighbourhoods better situated. It is not uncommon to have two or three consecutive cases of fever in the same house, and year after year, the father or the mother of large families is carried off by the frequent recurrence of the disease, produced by the malaria which is constantly forming in these open sewers. I may mention by way of example, the case of a widow woman and her two sons, who were attacked a short time ago with fever in Brunswick-place, the mother and the youngest son ultimately recovered, but the eldest son, about 20, on whom she entirely depended for support, was carried off. Thus she became a direct burthen to the parish. My experience could furnish many similar cases. Malignant cholera commenced in this locality and spread to a much greater extent on the line of these sewers than in the other poor densely inhabited places. I regret I have not the means of estimating the exact proportion of deaths from this cause; but in Brunswick-place where the disease first began, five fatal cases occurred in one house, (here the open sewer runs within two yards of the houses,) and in many instances in the direction of the ditches, in a better class of houses; two or three cases terminated fatally from malignant cholera in the same dwelling. There are other diseases produced by the malaria emitted from the decomposed refuse in these open sewers. Diarrhoea and a long catalogue of strumous affections are some of them. The former disease is sometimes very severe in these localities, and in the autumn prevails in the epidemic form. The too free indulgence in fruit has been the assignable cause, whereas it is now ascertained beyond a doubt that open sewers, stagnant ponds, and masses of vegetable matter, furnish the chief sources of the disease called English cholera.

“Have you any means of stating in what proportion deaths from cholera occurred in the line of the open sewers as compared with the proportion of deaths amongst the labouring classes living in better situated tenements? What is the sanatory condition of the children living in these places?—I am surgeon to an infirmary for children in the neighbourhood, and my experience enables me to state, that we have a much greater proportion of strumous ophthalmia, mesenteric disease, and other glandular affections in the children living in these places than in others of the same class, residing in more healthy situations.

“Are the better descriptions of houses in your district well cleansed

Mr. Joseph Quick

by drains and sewers?—I regret to say that the drainage of houses generally is very imperfect, for the want of well-constructed drains *from the houses into the sewers*. In my immediate neighbourhood houses which average a rental of 80*l.* a-year are either drained into cesspools, or by such small and imperfectly constructed drains, which, connecting as they do, the drainage of many houses together, are constantly getting stopped up, either wholly or partially; the consequence is, the kitchens and the lower offices are never free from offensive smells, and at particular seasons they are so excessive as to communicate them to other parts of the house, which are highly disgusting and prejudicial to health. It may, I think, be fairly asked, is it possible that this state of drainage can have existed for, probably the last 30 years, in the first class of houses in Blackfriars-road in a situation having a large sewer running in the middle of the street, and passing within two or three yards of the kerb-stone: yet this is literally the fact, with the exception of some half-dozen houses which have been recently drained by making a direct drain from the houses into the sewer at the occupier's own expense.

“What may you have paid in sewers'-rates during the time you have occupied your own house?—I have occupied my present house about 10 years, and a former one, which is situate nearly opposite, seven years, at a rental of from 70*l.* to 75*l.*, and I have paid sewers'-rates during my 17 years occupation to the amount of about 28*l.* I now hold a lease for a term of 14 years, seven of which are unexpired, and my landlord and myself are at issue at the present time about the expense of making a well-constructed barrel drain into the sewer.

“What sanitary effects are perceptible from the imperfect house drainage and cleansing into the sewers?—Fever is the most frequent consequence of this imperfect and disgraceful state of drainage, but there are other effects observable, such as low nervous debility, diarrhœa, &c., &c. Indeed, the same observations, which have been made on the baneful influence of open sewers on the health of those who live in their localities will equally apply to those who live in houses imperfectly drained.

“What would be the effects of the thorough drainage and cleansing of houses by supplies of water, and conveyance away of the refuse by well-washed and closed sewers?—The beneficial results would be immeasurable, it would be the greatest boon that could be conferred upon society. It is amazing that with so much inquiry, and such convincing evidence on these subjects, it should be permitted to remain.”

John Clarke, Esq., Medical Officer of St. Olave's Union.—

“What is the state of the residences of the poorer classes in your district in respect to cleanliness?—They are filthy in the extreme; the chief drainage of the district inhabited by the poorer classes is by uncovered sewers, which are a sort of ditches, very sluggish, and emitting constantly most offensive odours. The line of houses where fever prevails at some periods often marks the line of defective drainage and the open sewers.

“How are these sewers cleansed?—They are cleansed by men expressly appointed for the purpose by the Commissioners of Sewers. These men empty the contents of the sewers on to the bank, from

whence it is carted away. The occupation is considered so injurious to these men that I am informed they are only employed a part of the day, and receive proportionately high wages for the work. I think it is only four or six hours a-day they work. Mr. Joseph Quick

“What is the appearance of these men?—Some have been engaged for years in the occupation, but they were men of peculiarly robust constitution; but they now look pallid and unhealthy.

“How long do the accumulations remain in these sewers?—I think they are cleansed once in 12 months, the summer being of course the time selected for the purpose.

“Do these sewers in which the accumulations take place receive the night-soil from the houses?—Yes, the houses closely abut on these open sewers, and night-soil and every description of animal and vegetable refuse is thrown into the sewers. The cholera was very destructive along these lines of sewers. I believe I had under my own treatment the first cases of real cholera that occurred in London. There were one or two cases which were said to have occurred at Shadwell or Wapping. But the first cases, I believe, occurred in this parish. The cholera cases principally occurred in the houses near to or over the open sewers. Out of upwards of 400 cases in the one parish, almost 200 perished. I had most satisfactory evidence of the non-contagious character of the disease.

“Can you state in what proportion the deaths occurred near the line of these open sewers as compared with the proportions of deaths amongst labourers of the same class, but occupying better conditioned tenements?—The records not having been preserved, it is impossible at this distance of time to state the proportions of deaths from cholera occurring near the open sewers as compared with other parts, but my recollection clearly serves me in the fact that by far the greater majority of those attacked were residents of the district described, and there its ravages were most felt.

“Have you observed any evils accrue from the accumulations of refuse in privies or cesspools?—Yes; fevers of a low type, produced at particular seasons; they are very prevalent when the atmosphere is close and damp.

“Are there supplies of water laid on to the houses of the poorer classes?—Hardly any of them have supplies of water laid on in the houses. Most of them have water by a tap in the courts, but some of them have not that. In many of the courts there is none other than a surface drainage, a privy at one end being situated over the open ditch or sewer common to all the inhabitants, all refuse water and other impurities being thrown out to find its way into the kennel.

“In cases where water is not laid on in the houses, or where it is not sufficient in quantity to scour the house-drains, are not the drains themselves sometimes as offensive as if there were no drainage whatsoever?—Decidedly so.

“Therefore a provision to make drains from houses to the sewers without a provision for bringing water into the houses, would be of very limited utility in a sanatory point of view?—It would merely increase the accumulation of decomposing refuse, by which the drains themselves would eventually be choked up.

“Would efficient structural arrangements for cleansing such places

Mr. Joseph Quick as you are most frequently called upon to visit be economical to the poor-rates?—Most decidedly, they would be attended with a considerable reduction of expense, by diminishing disease with all the contingent charges.

“What is the physical condition of the population brought up under these noxious physical influences?—The children are stunted in growth, of sallow complexion, of rather sickly hue, though apparently stout in limb. Those of them who have the appearance of health, do not bear the attacks of disease like healthy children, and disease is very fatal to them; though the people have many children, they have not large families, for the young die quickly. It is common to the parents to enumerate the children they have lying in particular churchyards as a plea for their continuance when told they are to be removed to their legal place of settlement.”

—These descriptions all coincide with my own observations. I know them to be correct. The supplies of water are in most cases defective, from its not being carried into the houses, and from the stand-pipe system of supply being the one in use.

Supposing it were ineligible or impracticable to relieve the district by widening the main sewers, and quickening the discharge into the river during low water; as you daily pump a lake of water into the district, do you, as an engineer, doubt the practicability of relieving it by pumping the sewage out of it, and carrying it to any district where it may be available for use to agricultural purposes?—There would be no impracticability or difficulty if the sewage were collected into shafts, as it could be pumped out through large mains to any districts where it might be required. The expense of doing so would be less than that of pumping water through the mains and minor distributionary branches required for supplying a district.

Do you happen to know the expense of cleansing cesspools in your district?—I have myself paid 1*l.* each time for small tenements, and as much as 3*l.* for large ones.

What would be the weekly expense of properly cleansing cesspools even with the relief by permeation of which you speak?—Judging from the experience of about 90 tenements which I own or manage, I conceive it would be about 3*d.* weekly. Twenty of my own, from four to eight-roomed houses, do absolutely cost about 3*d.* per week for cleansing the cesspools.

In other places the expense is stated to be upwards of 1*l.* per annum, or about 5*d.* weekly. The reduction of expense in the Southwark district will be obtained by the more extensive escape by the permeation of the substratum of which you have spoken?—Yes, that is the case. On the Southwark side the springs are on the average from 8 to 12 feet; whilst on the City side wells must be sunk from 30 to 70 or 80 feet. Within

a few days we have had an instance at Battersea of the per- Mr. Joseph Quick
meation of the cesspools in six new houses. They were supplied with water from springs sunk to the same level as the cesspools. As the springs were lowered by the consumption of the water, it was found, to the surprise of the inhabitants, instead of coming up clearer, it was more discoloured—by the equalization of the water levels. One of the inhabitants, a baker, who drew harder than the rest, applied to the Company to lay on the water, giving me to understand that the people began to complain of the quality of his bread, the cause of which he could not make out, except it arose from the quality of the water, which somehow or other was very bad. All his neighbours, who drew from the same spring, complained that the water was very bad. The cause was, on examination, undoubted. Ancient and celebrated springs are now being discontinued throughout the district; wells which were much frequented are now gradually being abandoned by the inhabitants; the pumps remain, and are used by the poor who pass by, and who do not know their reputation; people have imagined that it is the gas which has polluted the water, but it is the cesspools that are now being sunk so much lower than formerly, partly that the water in the cesspools may not be higher than the level of the springs, and partly for the economy of cleansing. Instead of having a waggon load of liquid refuse to remove, they have now only a cart load of the solid refuse to convey away. In the village I have mentioned there are no gas-pipes.

Supposing that the Company was enabled to give a constant supply of water at the additional charge of $1\frac{1}{2}d.$ per week per tenement, which you state would be requisite, and that by cheap drainage and the use of the soil-pan apparatus such as described by Mr. Foden, do you see any reason to doubt the general conclusion as applicable to the poorer districts, that the existing charges for cleansing may be reduced by such improved means?—If the drainage were improved and cheapened, and the measure were general, I should come to the same conclusion.

What are the charges for entering the sewer by a drain from a private house of any class?—The charge is half a guinea for each entrance. I have paid several such fees. But beyond this they prescribe that the smallest drain which shall be admitted into the sewers which they construct shall be 15 inches in diameter, made of brick, and at an expense of $4s. 6d.$ per foot, inclusive of everything. This is required to be constructed by the contractors or persons connected with the Commission of Sewers.

Do you think it objectionable that the subordinate drains should be made by those who are responsible for the construction of the main drains or sewers?—By no means. It is in-

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deed not only desirable, and I conceive necessary, that it should be all one work, but it should certainly be required to be done for the parties with the advantages of the cheapest construction. If the construction were allowed to be that which the Commissioners prescribe, even private bricklayers would lay down such drains at nearly one-half the expense now exacted. In 20 feet of any single drain the saving would more than pay the expense of laying on water into the tenant's premises. But I fully agree that tile-tube piping of a proper make would act much better (being impermeable), at the most at 1s. a-foot. They might be made with cone joints, so as to be luted together with a little cement, and render bricklaying unnecessary. There might, in the district of the Kent and Surrey Commissioners of Sewers, be considerable saving of the main-drains if, instead of draining from the back part of each house through the front, they drained from the back of the houses into a small barrel-drain behind, and carried that barrel-drain through the back gardens into the main sewer at the end of the street or row of houses. Shorter house-drains would then serve, and there would only be one opening instead of many into the sewer.

Is the whole expense of these subordinate drains from the houses to the sewers required to be defrayed at once as an immediate payment?—Yes.

For the owner who has only a short interest, for the lessee with a short term, or for the tenant-at-will, are there no means of distributing the charge over any term of years coincident with the benefit?—None, as the law now stands.

And these obstructions to the house drainage you find operate powerfully as barriers to the introduction of the use of water into the houses?—Yes, chiefly in the poorer districts.

You have spoken of the evils to the people themselves from the system of supply by stand-pipes instead of a supply carried into each house. What are those evils?—The labour of fetching the water, the loss of time in waiting for what they call their turns, and the demoralization from the numbers brought and kept together. I have seen as many as from 20 to 50 persons with pails waiting round one or two stand-pipes. Then there is quarrelling for the turn; the strongest pushing forward, and the pails, after they are filled, being upset. In the winter time, the inconvenience is increased by the liability of the cock being frozen, and injuries to the health from the weather, and getting wet-footed. It also happens frequently that the man and woman are out at work during the time the supply is on the common tap. When they return home there is no supply, and this may occur from day to day: if the man has work, he is generally out, and a large proportion of the women work from home.

What is the rate of wages in your district for labouring people?—For the lowest class of labourers it is from 15s. to 17. 1s. per week; for mechanics from 24s. to 35s. and 2l. Women get from 1s. to 2s. per diem.

Then the system of supply by stand-pipes must be an extravagant waste of labour to them as compared with the expense of having water laid on?—That is peculiarly so in our district, where so many even of the children are engaged in hat-lining, and various sorts of work, which makes every moment of time of very great importance to them. Many of them object to take goods home to the shop if it be at a distance, without extra payment, on account of the loss of time.

Are water-carriers still employed and paid in the district?—Yes, in some part of the district, such as at Clapham and Rotherhithe.

What is their charge?—A halfpenny for two pails, or for one turn.

How much is paid per week for water supplies?—Some pay 1s.; laundresses, who use much water, pay as much as 3s. a week.

And in such instances do your own pipes pass near the tenements?—Sometimes before the doors.

What is the obstruction, then, to the supply being laid on?—The first obstruction or their objection is to the expense of the first outlay for laying down the length of service.

Are they mostly tenants-at-will?—Generally they are.

Are they weekly tenants?—Some of them are, but most of them monthly or quarterly.

Have the Company ever endeavoured to overcome the difficulty by laying down the pipes and charging for the outlay as for a rent?—The objection to the Company doing so is, that they have no security for the repayment of the outlay. When the tenants' communication-pipes are laid down, the Company may have their pipes put on to the service of another Company.

As a matter of hydraulics, would it not be essential to any perfect and economical system of supply that the pipes for the minor distribution should be laid down on one general system, and be placed under one general authority?—Yes, certainly; if this were done there would not be half the leakages there are. This amendment would be the more necessary for the protection of the consumer, as since the introduction of drawn lead pipe cast pipe has been nearly superseded, and a large portion of the drawn pipe being made very thin and irregular, it is liable to split, and soon becomes defective, and private individuals not being aware of any difference, seldom make a proper arrangement with the plumber in this particular.

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It is stated that the expense of laying on water to two-story houses with the butt and ball-cock apparatus is usually about 4*l.* per tenement?—I believe it may be about that on the average.

If the water were laid on under a general system, even with the existing apparatus, at what reduced charge might it be accomplished?—1*l.* out of the 4*l.* at the least might be saved to the tenant, and by the introduction of iron piping at least 10*s.* more.

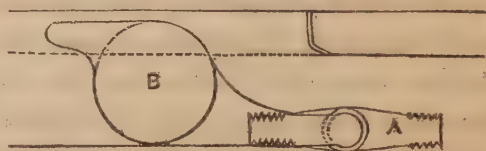
Have you used iron tubing for these purposes?—I have recommended its use in many of the poorer districts, and wherever it has been used it is found to answer remarkably well.

What sort of iron pipe is it, cast or wrought?—Wrought iron, of the same description as that used for gas services.

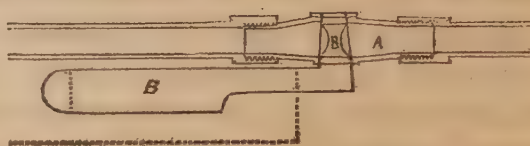
How long has it been in use?—From six to seven years. I believe it will last longer than the lead pipes, and as good bends may be made with it as with lead pipes. Iron tubing is used for high-pressure engine pipes, and they are made to stand any pressure. It has also been used in respectable tenements. The people, however, commonly go to the plumbers and the plumbers prefer the lead pipes; but I have no doubt that the iron pipes will ultimately in a great measure supersede the use of lead.

What is the comparative expense?—The lead pipes are generally sold at 6½*d.* or 7*d.* per foot, weighing 2½ lbs. to 3 lbs. whereas the iron pipes may be had to serve the same purpose at 4½*d.* per foot: they would both be ¾ inch diameter. This, however, is the retail price. If it were had in quantities it might be obtained from Staffordshire at perhaps 20 per cent less. The expense of joints are saved by the use of iron pipes. The iron joints are made with the pipes, and any workman may screw them together with a pair of pincers. If any accident occur, any person may unscrew the pipes, and introduce and screw in a new piece. The following is a sketch of a common stop-cock, made to work in with the iron tubing, and which can be manufactured complete, for ½-inch 1*s.* 6*d.*, and ¾-inch 1*s.* 9*d.*

A A brass cock,
with a screw
at each end.



B B cast iron
plug, with
handle.



Would it not also be an additional recommendation to the iron pipe that, besides being so much cheaper, it would be less

exposed to injury or depredation?—Certainly. In the small Mr. Joseph Quick houses the lead is often knocked about, and crushed, and perforated, and great waste of water is occasioned. The iron is not liable to injury in the same way. Wherever a lead pipe crosses a drain, a rat will, for some unexplained reason, gnaw or scratch a hole in it. Instances of waste and inconvenience to the inhabitants from this cause is in our district an event of almost every day occurrence; but I have never seen the marks even of any such attempts upon the iron tubing.

Have you met with instances of injuries to the health from the oxide of lead?—At Clapham Common the Manor Estate was supplied with water from a spring well in the centre of the Common, through the lead pipes, and the inhabitants were attacked with severe illness, which was ascribed to the length of lead pipe through which the water passed. Lead was detected in the water upon analysis, and the lead pipes were taken up and iron pipes substituted. The pipe was nearly a mile in length and of 5 inches in diameter, and always full of water, serving as a species of reservoir to the houses it supplied: the quality of the water might also have had some influence in the decomposition of the lead. I have never known, or heard of the least suspicion, that the short leaden services from the iron mains in the street into the houses have any effect on the water passing through them.

Pipes of fire-brick clay, of an inch thick, and 4 and 6 inches in diameter, have been produced to the Commission, which have sustained a pressure of upwards of 900 feet before breaking. Supposing such pipes to stand a continuous pressure, and to be fit for general adoption as mains, what will be the comparative economy produced by substituting them for iron mains?—The expense of laying down pipes in our district is generally about one-third the expense of the pipe; that is, for cartage, digging, and jointing, and removing rubbish, all complete, except the expense of paving, which is, for pebble paving 9*d.* per yard, for square paving 1*s.*, and for grounded paving 1*s.* 4*d.*, charged by the district surveyors. This expense may be said to average 1*s.* per yard; so that supposing iron, stone, or fire-brick piping to stand, or the 6-inch mains of that substance at 1*s.* 6*d.* per yard to be substituted for the 6-inch iron mains now sold at 5*s.* 6*d.* per yard, as the expense of laying down earthenware, which did not require lead jointing, might be about 9*d.* per yard, the whole expense of the earthen mains would be about one half the expense of the iron mains. It is an illustration of the separate mode of action that the contract price of the same contractors for paving for the Paving Commissioners is only 4½*d.* to 5*d.* per yard. If the paving sink, they are paid for repaving it, and the same place is frequently paved three times.

Mr. Joseph Quick

If the earthen pipes were successful, to what extent would they reduce your estimate of the expense of the introduction of a system of constant supply at high pressure over the whole district, which you have stated at $1\frac{1}{2}d.$ per week for each house?—It would, I think, reduce the expense by about one half penny.

And get rid of any chalybeate effect of the iron upon the water, or of the pernicious effects of oxides of lead, and all the wear and tear from corrosion?—Certainly. Another advantage would be, that consumers might use the pipes immediately they are laid. At present it is somewhat more than a month before they can be used, or before the water is free from the rust of the iron pipes, and from the tarred yarn used in making the joints.

In the crowded manufacturing districts, do you find the water in the butts exposed to soot and dirt, and polluted from neglect?—In going over those districts we frequently find the butts uncovered, and the water exposed and covered with soot and dust in warm weather. I frequently find a green scum upon them, which I have imagined arises from some decomposition of the wood. The butts themselves are not well prepared in the poorer districts; old tallow casks, old rum puncheons, anything in shape of a tub is, in fact, used, and commonly with little or no preparation, and the matter with which the wood has been saturated will taint the water for a long time. A butt ought to be dressed over with common pitch once each year to preserve it properly, but this is rarely done.

Does not the water also absorb the gases by which it is surrounded?—That is a fact of which I cannot speak. It is stated to be so by medical men, and I have little doubt that it must be so. We know that when water is placed in a newly painted room, it removes much of the unpleasant effluvia.

Do you filter the water supplied by the Southwark Water Company?—Yes, we have done so during the last three years and a half.

Do you attain the same degree of clearness that is attained by private filters?—I believe we do. Before we filtered and during the time when we pumped the water direct from the Thames near London bridge I have seen as much as three inches of deposit taken out of the butts in one week, when there had been heavy falls of rain, and the Thames was discoloured; but since the works have been established at Battersea, and the process of filtration made perfect, the deposit during six months in close covered tanks has not been thicker than a shilling. I consider when Thames water is purified by deposition and filtration, it is better than spring or Wandle river water and softer and fitter for domestic purposes.

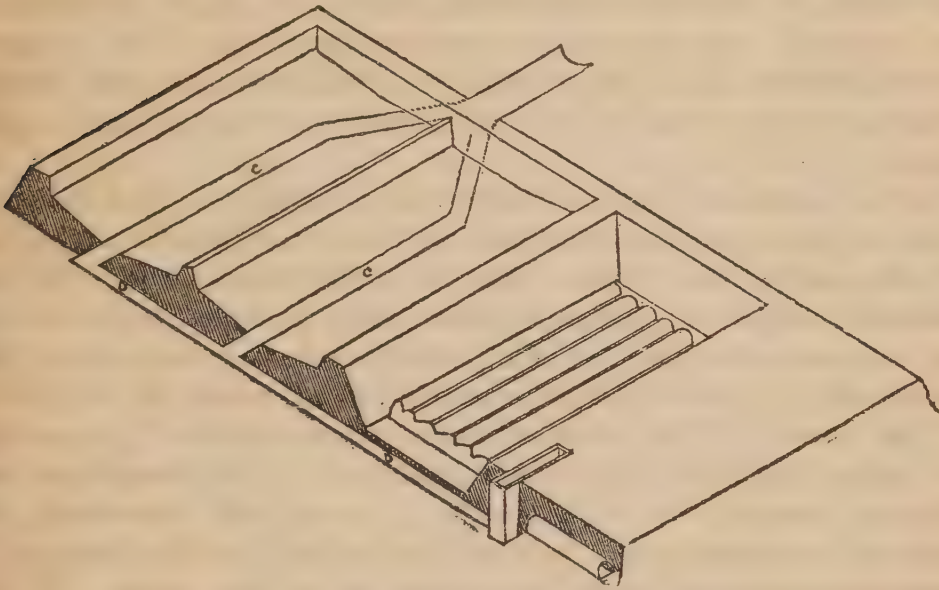
What is the construction of the filter you have in use

the Southwark Waterworks?—Our process of cleansing is first by reservoirs of subsidence, large open reservoirs between four and five acres in area and thirteen feet six deep, faced with gravel. Where the bottom was springy we mixed lime and made a concrete with the gravel. It also gave a surface for cleansing. These reservoirs have a brick invert about six feet wide and three feet six deep, laid in cement.

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The following [fig. 1.] is a section of our reservoir with the

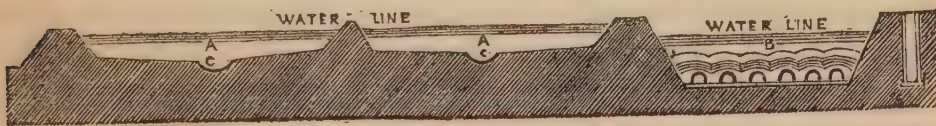
Fig. 1.



invert in the centre. Usually reservoirs of subsidence have a nearly plain surface; but we find this invert a great improvement. We sweep the deposit into the invert, and then flush it away by letting water into the invert from an upper reservoir. We could not apply the flushing principle except by the use of such means.

Our filters are constructed on the same principle as those in use at the Chelsea Waterworks, namely, by strata of coarse gravel arranged as shown in the accompanying plan. [Fig. 2.]

Fig. 2.



A A, depositing reservoirs, capable of containing four days' supply. c c, inverts, formed of open brick-work in cement, used for cleansing and flushing out. B, filter bed, showing the filtering substances, consisting of, 1st, coarse gravel about one foot deep; 2ndly, a stratum of rough screened gravel nine inches deep; 3rdly, fine screened gravel about six inches deep; 4thly, hoggin, or fine gravel nine inches deep; 5thly, fine washed grey river sand about three feet six deep. The water is gradually drawn from the depositing reservoir on to the surface of the sand, and is allowed to percolate through tunnels

Mr. Joseph Quick formed by bricks, with open joints and cement. These lead to other tunnels, which are made of close brick, and lead into the pump-well of the engine.

Are you confident as to the principle of this filter, and its completeness?—All that I am prepared to say at present is that I have seen nothing yet answer so well as this filter with the reservoir of subsidence attached. Indeed, at times the reservoir of subsidence renders the water very pure of itself. My own impression, from all the experiments I have seen, is that extent of surface is necessary for filtration. Filters have been invented which do with small surface, but they require great pressure; and, so far as my observation has gone, unless the water is previously very pure, the filtering medium gets soon clogged up and consolidated by the pressure, and a more frequent cleansing, and consequently greater expense is incurred. The expense of filtration by the Chelsea Filter is estimated at 2,185*l.* per annum to produce 3,136,320 gallons or 72 gallons per superficial foot of the filtering bed per diem. The cost of ours, the Battersea filter, to produce 2,160,000 gallons, or 66 gallons to one foot each day, does not exceed 350*l.* per annum. We never find the upper stratum of sand discoloured more than from an inch and a half to two inches.

That is to say, perceptible to the eye?—Yes. By the process of cleansing, and the removal of about an inch of surface the sand is renewed about once in three years.

What is your experience as to the amount of matter detained by subsidence?—About one inch per month of mud; or rather on the average of the year it is 12 inches. In fine weather there is very little, but during and after heavy rains there is a great quantity, which makes up the average.

Besides this, what quantity is detained in your filtering beds?—About an eighth of an inch of mud, and below that an inch of discoloured sand every eight weeks. But this eighth of an inch is so compressed as to be equal to at least half an inch of the mud left in the reservoir of subsidence. Altogether the Thames water, as taken out at Battersea, would give about 15 inches of deposit in the year.

This then is the measure, is it not, of what must pass into the water-butts, and require cleansing, where the same water is taken up and delivered without previous preparation by reservoirs of subsidence and filtering beds?—Yes.

And what for each 1000 gallons is the extra expense of cleansing such water?—About one-sixth of a penny. For a tenement receiving 40 gallons per diem, the expense will be about 4*d.* per annum;* and for this a cleansing of the butt every week or fortnight is saved. Besides, the filtered water may be at once used, and the consumer has not to wait for any

* This sum will include the interest at 5*l.* per cent. upon 12,000*l.* expended on the reservoirs and filters.

subsidence. Brewers, manufacturers, and all other consumers, have the same advantage. Formerly, when there was subsidence, deposits were left at the bottom of brewers' coppers, which furred them so much that holes were frequently burnt into them. Now that the clear water comes directly in contact with the metal, such accidents do not occur to the same extent. The housewives' kettles are also better preserved. The fellmongers also dress their wool whiter, and those who use the filtered water get an advantage of about three farthings in the pound.

What was the expense of the reservoir of subsidence and of the whole apparatus used at Battersea?—About 20,000*l.*, inclusive of the filter beds.

You are aware, perhaps, of the fact that if water, having infusions of decaying organic matter, be altogether secluded from the light, the appearance of animalculæ is much retarded. Is not this an observation applicable to the reservoirs of subsidence as well as to the exposure of water in the water-butts?—There may be something in that; but our reservoirs of subsidence are so constructed that we can at once change the water by letting it out into the river, and by taking it in again at the next tide. In the summer weather we frequently do this; we let the water out in the afternoon, and take in a supply of cool water for the next day's distribution. At the Chelsea Waterworks the reservoirs are so constructed that they would have to "lift" their water, which would be an extra expense.

Then by getting rid of the water-butt, its pollution would be got rid of, and on a system of a constant supply of water from a large reservoir, filtered water would be drawn fresh and cool in summer, as from a spring, having the coolness or medium temperature of the earth through which it passes?—Certainly, and the medium temperature would be good for the supply in winter.

If the butt were got rid of by the system of constant supply at high pressure, supposing adequate powers were given, and the water were laid on by the Company, at what expense per tenement could it be done?—I believe that, with iron pipes, it might be carried up to the first floor, at an outlay of from 20*s.* to 25*s.* per tenement, that is for a four-roomed house; a further economy might be effected, by carrying up one service for two houses, and making branches from it.

For steam engines, is not filtered water found advantageous?—Our water is taken at the South-Western Railway station on that account, and several of the manufacturers express great satisfaction with it on account of its filtration.

Do you conceive that when the economy of filtration on a large scale is considered, and its necessity for domestic pur-

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poses, all supplies of water for the public should be required to be filtered artificially, as yours is, where it cannot be filtered naturally?—There can be no doubt of it.

Did you superintend the experiments as to the force of the jets given from your different sized mains, and recited in the examination of Mr. Hawksley?—Yes, I did.

Have you had occasion to advise as to the disposition of water at high pressure, for the prevention of fire?—Yes, after the destruction of the terminus of the South-Western Railway by fire, I recommended them to have a nine-inch main, with three-inch outlets leading to six stand pipes, with joining screws for hose pipe to be attached, and that they should carry a three-inch pipe of the same description up into each floor, so that a hose might be attached in any room where the fire commenced. This was done between two and three years ago. I have recommended similar precautions, which have been adopted at Messrs. Price's, cocoa-nut oil manufacturers, Wandsworth-road. Messrs. Pilchers, white-lead and oil merchants, Morgan's-lane. Messrs. Hepburn, tanners, in Long-lane. They have similar protection at Guy's Hospital. The insurance company refused to insure Messrs. Price's premises until this means of protection were adopted. From London Bridge to Rotherhithe, a district covered with warehouses, and where some of the most destructive fires have lately happened, there is no water main. The insurance on those buildings is consequently higher.

In these instances of course the pipes are all attached to your mains, which are kept constantly charged night and day, at your pressure of 120 feet?—Yes, certainly.

In how many minutes may the hose be attached?—There is only the time of attaching the hose which need be nothing like a minute. I have indeed recommended that a short length of hose, with a short nozzle, or branch, should be kept attached to the cock, so that the cock has only to be turned which is done in an instant.

It appears that fire-engines require 26 men to work each engine of two seven-inch barrels, to produce a jet of about 50 feet high. The arrangement carried out at your recommendation with six jets, is equivalent to keeping six such engines, and the power of 156 men in readiness to act at all times, night and day, at about a minute's notice, for the extinction of fires?—It will give a power more than equal to that number of men. For the jets given off from our 20-inch main will be much more regular and powerful, and will deliver more water, than could be delivered by any engine. The jets at that place would be 70 feet high.

Under a system of constant supply at high pressure, such as that for which you have made an estimate, even the smallest

street might be supplied with a three-inch main, affording one 40-feet jet at least, that is equivalent to keeping the power of one engine and 20 men in readiness at every house-door to act at one minute's notice, in case of fire?——Certainly.

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Would it not be equally practicable and desirable to carry a nine-inch or some such main with similar appliances to the vicinity of the warehouse property along the river side, and would not the reduced risk largely cover any increased expense?——There can be no doubt of it.

Are there not large masses of warehouse property along the banks of the river from London Bridge to Rotherhithe which have no such protection?——Yes, from Southwark Bridge to Rotherhithe there are few places with any pipes at all, and those which they have are very small, and by no means equal to the purpose. In several places there are large stacks of warehouses containing property to the value of several hundred thousand pounds without any protection whatever. Since the last conflagration an addition of two or three shillings per cent. has been made to the insurance premium in consequence of the exposed state of the property. They may conceive themselves protected by the contiguity of the river, but it is not so. If a fire take place when the tide is out, as at the last great fire at London Bridge, not only the warehouses must go, but the vessels lying alongside, until the floating engines can be fetched from a distance.

Has water been as yet used at high pressure for street cleansing?——At St. Thomas's Hospital, they have stand pipes to the columns that support the building for the purpose of cleansing the square in the front of the hospital. They also use the jets for cleansing the front of the building, and washing the windows. In the summer time they wash the place once a fortnight, and sometimes oftener. They say "it cools the place and makes it fresh," in hot weather.

Under a system of constant supply of high pressure, the same thing may of course be done for the streets and houses, as is stated to be the practice of Philadelphia?——Yes, I have no doubt that it might be done, but I have not had any experience, or made any experiments upon it.

As the public are at present supplied in the Southwark district, how many capitals are invested, and how many sets of pipes traverse the same streets?——There are three companies in some streets, and three sets of pipes, in others two; and we have at the present the exclusive supply of about one-tenth of the district. On the average there may be said to be about two capitals in the same street. This is also the case with supplies of gas. In no part of the district is there less than two capitals in gas supplies in the same street, and in a very large portion three.

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What dividends do the Water Companies pay?—The Southwark Company have expended, from 1819 to the present time, taking into account the money spent as well previous as subsequent to the removal of the source of supply to Battersea, 208,000*l.*, and the dividends now paid amount to 6,400*l.*, being a little above 3 per cent. The outlay of the two other companies south of the Thames cannot have been less together than 450,000*l.* Of the three, consequently, in round numbers, 650,000*l.*, and the dividends at present paid (the Vauxhall paying none) are 16,400*l.*, or $2\frac{1}{2}$ per cent. on the whole amount expended; and should the companies recover in a few years from the loss and waste produced by the competition, they would scarcely be able to pay more than from 3 to $3\frac{1}{2}$ per cent., as the gross income does not exceed 40,000*l.*, and the expenditure amounts to not less than 20,000*l.*

What might be the gain to the public by a consolidation?—If the companies could be consolidated, and were to take their supplies from the Southwark Company's works at Battersea (the highest of the three establishments up the Thames), the public would be supplied with better water, and the protection in case of fire be made more effectual, and more universally spread over the district, and an economy to the public of from 6,000*l.* to 8,000*l.* per annum in expenses be effected.

If the companies south of the Thames had confined themselves to separate districts, would it not have made a considerable difference in the rate of charge to the consumers?—If there never had been more than one company in the same district, all the expense of competition, so ruinous to the capital of a company, would have been saved, likewise the loss of income by change of tenantry, and the consequent expenses of plumbing, paving, &c.; and this will inevitably apply where two or three companies occupy the same district, and tend to prevent an adequate return for the capital expended, until companies are forced into arrangement with each other for their own safety and the security of their investment, and which arrangement is always against the consumer. In reference to such expenses I mention the case of St. John's Southwark. The Southwark Company had served the parish for many years, having pipes in every street. In 1841 the Vauxhall Company laid pipes in nearly every street in the parish, at an expense of 2400*l.* and succeeded in procuring a rental by change of tenants from the Southwark Company of 81*l.*: for the time the rates throughout the parish were reduced 25 per cent.; in 1842 the competition ceased by arrangement, and the rates were raised to the same, or to a somewhat higher level, than they were at before the competition commenced, although they are still much below the Parliamentary scale of rates.

What dividends are the gas companies paying?—The best is now paying 6 per cent., and the worst nothing; the South Metropolitan is paying 6 per cent.; the Phoenix 5 per cent.; the London pays interest on debentures, but little to the shareholders; and the Deptford Company is in want of money to get on.

Though the shareholders of the rival water companies are paid but indifferently when risks and unproductive capitals of some of the companies are considered, must not the whole district be paying upwards of 10 per cent. for very imperfect supplies of water?—It may, supposing no capital to have been wasted in competition, and no money expended but on the best plan that could be devised for supplying the inhabitants with water, and protecting the district in cases of fire. The present rates might possibly pay 10 per cent. on a capital of the amount barely necessary and so expended; but it should be added in fairness that no great works, whether railroads, canals, docks, or waterworks, have ever been executed of which it may not be true, that if to be done again much money might not be saved.

A general supply of water over the whole district for the cleansing of the houses and the drains being required for the improvement of the sanitary condition of the population, do you conceive it would be eligible or practicable to get the several companies to act in concert for the purpose?—It would certainly be eligible in the highest degree, and would possibly be practicable under the influence of some superior authority, but from the jealousies of the companies, and the hostile feeling engendered by recent contests between all the officers and servants of the companies from the highest to the lowest, there would of course be much difficulty in getting them to act in concert.

Then you are of opinion that the only practicable course would be to resume all the privileges granted, and to buy up the whole works on terms of compensation to the paid officers, to shareholders, and to commence *de novo* under one authority?—I do not know that it would be the only, but it undoubtedly would be the best practical course. The public would gain much, and would be enabled to compensate all interested parties liberally. Everything might then go on easily without the obstructions of making bargains and settling conflicts at every step, or attending to any other than the public interest. There might be at once an immediate saving to the public of the greatest part of the expense of collection.

Do you see any difficulty in managing improved and constant supplies of water in connection and subordination to general arrangements, under one authority, for the house and street drainage and cleansing?—The chief difficulty would

Mr. Joseph Quick be the labour of making the required change. When once made, the system would work easily and in the best manner, if it were placed under scientific and competent direction as part of the general arrangements for draining and cleansing the district and the improvement of the sanatory condition of the population.

THE CITIES OF PHILADELPHIA AND NEW YORK.*

SUPPLY OF WATER.

Philadelphia and
New York, U. S.

1. At what height is the surface of the water in your reservoirs above the highest and lowest points in the city and suburbs?

Philadelphia.—The surface of the water in the reservoirs is 98 feet above high-water mark of the rivers Delaware and Schuylkill: highest point in the city 43 feet 2 inches; lowest 5 feet 5 inches.

New York.—The height of the water is 115 feet above tide,—about 105 feet above the lowest and 60 feet above the highest grade of streets. Only a small portion of the city less than 75 feet below the surface of the reservoir.

2. How many miles of mains are laid down in the city and suburbs, and how many miles of services?

The term main applies to iron pipes always charged with water, and the term services to iron pipes communicating with the mains, and only charged occasionally.

P.—There are $115\frac{1}{2}$ miles of mains, service pipe not included:—

One main = 22 inches in diameter; length 9,570 feet.

One main of 20 inches in diameter; length 10,152 feet.

Pipes in the principal street = 12 inches diameter.

Pipes in the minor streets and alleys 4 and 6 inches diameter.

These pipes are proved by Bramah's pump under a pressure of 300 feet head of water.

There are connected with the mains for protection from fire 1055 fire-plugs.

N. Y.—There are 150 miles of mains, besides 40 miles of aqueduct. The sizes vary from 36-inch to 6-inch. They are always charged. The services are from the street to the houses.

3. What is the distance from the reservoirs to the extreme points of the mains that are always charged, and of the services that are occasionally charged?

P.—The distance from the reservoirs to the extreme point of

* For these answers the Commission is indebted to Mr. William G. Bull, of New York, civil engineer, who furnished the information relative to New York, and to Mr. William Strickland, architect and engineer to the Schuylkill Waterworks, who supplied that relating to Philadelphia.

he mains and pipes that are always charged is six miles. There is constantly a full head on all the pipes of the streets.

N. Y.—The distance from the distributing reservoir to the battery is four miles, a direct main of 36 inches.

4. What is the experience of the loss of level by friction in the pipes?

P.—The loss of head by friction in the pipes is about 25 feet while the city is drawing.

N. Y.—The formula of Robinson, as given in his "Mechanical Philosophy," article "Waterworks," may be fully relied on as practically demonstrated.

5. To what height does the water rise above the ground when allowed to escape from any orifice in the mains at the nearest and furthest points of delivery? and the same as regards the services?

P.—This question involves the size of the orifice: an inch bore will admit a vertical jet of 30 feet at the nearest, and of 20 feet at the furthest points of delivery from all the pipes. The term service is applied only to the small leaden or iron pipe leading into the houses on the right and left of the streets.

N. Y.—At Harlaem River-valley a 12-inch pipe, with a 6-inch jet, throws the water in quiet weather 100 and 110 feet high. The city fountains throw it 60 and 70 feet high.

6. What are the bores of the mains or services at these points, and what is the bore of the orifices?

P.—The bores of the mains are from 10 to 12 inches in the principal or leading streets, and from 4 to 6 inches in the minor ones.

N. Y.—The bores of the main 12 inches, jet 6 inches.

7. What are the heights of the highest and lowest houses in the city and suburbs above the ground level, and what is the general height of the buildings?

P.—The highest houses of the city are six stories, averaging 10 feet each story above the ground. The lowest two stories, say 25 feet above ground. The general height of the buildings is three stories.

N. Y.—The highest public buildings (except steeples of churches) 108 feet; lowest private 25 feet from the ground; three-story houses and attics 50 feet.

8. Is the water kept on at high pressure in all the streets, or only in the main streets?

P.—The water is kept on at high pressure in all the streets, and at all times.

N. Y.—The water is kept at high pressure in all the streets at all times.

9. If only in the main streets, why is it not extended to the subordinate streets?

P.—Answered in preceding.

N. Y.—See No. 8 for answer.

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10. What would be the expense of applying it per house to the subordinate streets?

P.—The city rates are 5 dollars per house fronting all the streets, and 2 dollars 50 cents. in courts and alleys. Baths 3 dollars. Water-closets, 1 dollar. Private stable, 5 dollars per annum.

N. Y.—The expense in every street is the same for the use of the water, dependent on the size of the house, number of stories &c. Two stories, 10 dollars; three stories, 12 dollars; public houses and manufactories vary as to size.

11. Has it yet become the practice to have the water laid on in all the rooms up to the attics of private houses?

P.—No; some few dwellings have it, and in some hotels it is introduced in all the rooms and attics.

N. Y.—About half the houses using the water carry it through the house.

12. Is it laid on in the rooms of warehouses or large buildings, so as to be in readiness on the occurrence of fire; if so, what sized pipes are used, and what regulations are made to prevent the water from being used for other purposes than for fires?

P.—It is laid on in the rooms of warehouses where required. The pipes = 2 inches, ferrule 1 inch. There are no regulations to prevent the water from being used for any purpose, provided it is not wasted.

N. Y.—They use the water for all purposes, the service on house-pipe being five-eighths of an inch; water gardens, streets &c.

13. In how short a time may a hose be attached to the main pipe, (on the pipe kept charged in readiness at high pressure,) and brought into an edifice to extinguish fires?

P.—A hose may be attached to a fire-plug in a minute.

N. Y.—Hose may be attached to main pipe in three to five minutes.

14. What is the actual practice in this respect? Describe any failures or impediments that have occurred, and any means proposed for removing them?

P.—The practice is to extinguish fires by hose and engine companies, and for this purpose fire-plugs are placed in the streets surrounding a block of buildings; a plug in every 400 feet of distance, making four plugs to a block of buildings; free pumps are also placed in every block; four of these, which are not only used for culinary purposes, but in cases of fire.

N. Y.—They attach the hose by screw to the hydrants in the street, without any delay or impediment.

15. Are there many wooden buildings in the city, or buildings with peculiar risks?

P.—The law prevents the construction of wooden buildings in the City Proper; but there are many in the liberties and suburbs which have peculiar risks.

N. Y.—About one-fifth of the buildings are of wood, and extra hazardous.

16. What number of fires have there been in the City during each of the last 10 years? Have the losses from fire been excessive in amount in any year?

P.—The average number of fires for one year during the last 10 years is not more than 36. The losses from fire have not exceeded 50,000 dollars per annum, for the facilities for their extinguishment are such as not to permit a fire to extend beyond the building in which it originates. This applies to the City Proper.

N. Y.—See the following extracts from the reports of the chief engineer of Fire Department for 1842 and 1843. The great fire of December, 1835, destroyed a vast amount of property, estimated at over 20,000,000 of dollars:—

			Dollars.
1842.	Number of fires	189	Amount of property destroyed 362,875
1843.	Ditto	221	Ditto 246,404
	Increase of fires	32	Decrease in property destroyed 116,471

During the last year seven engine companies have been disbanded, and two new ones organized.

17. What has been the number of fires attended with the destruction of edifices in this city as compared with the number in other cities or towns similarly circumstanced, except that they have not supplies of water kept constantly on at high pressure?

P.—The cities of Boston and Baltimore are watered from ponds or natural reservoirs on heights at several miles off. They have supplies of water kept constantly on at high pressure; and the destruction of edifices in these cities by fires is quite equal to that of Philadelphia, which contains more than double the number of dwellings than either of the above-mentioned cities. In Philadelphia insurance risks are taken at one-half the premium chargeable in Boston and Baltimore. This arises mainly from the admirable organization and *esprit du corps* of our engine and hose companies.

N. Y.—As other cities keep no official record of fires, it is impossible to say what destruction of property by fires in other places has taken place.

18. What was the state of the city in respect to the means of extinguishing fires before the present mode of keeping on the water-pipes charged at high pressure was brought into operation?

P.—The means of extinguishing fires in the city previous to the present plan of keeping on the water-pipes charged at high pressure were the same as now, with this difference, that the mains

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and pipes were constructed with wood. The water of the river Schuylkill was pumped up to a level nearly with the plane of the city, carried through a brick aqueduct of 5 feet in diameter, to an engine-house placed nearly in the centre of the city, and there pumped up again into a reservoir or tank under the roof, at an elevation of 45 feet above the surrounding streets. A distributing chest was connected with the reservoir of this central engine-house, and from which the great mains set out through the principal streets of the city. From the want of an adequate supply of water, and from the necessity of husbanding that supply by stopping it off in one direction or another, so as to meet the demands of a fire, only those pipes which led in the direction of the flames were charged at all, and the inhabitants made use of the common street pumps by forming themselves in double file to pass buckets of spring water as an auxiliary to the charging of the fire-engines.

N. Y.—The means of extinguishing fires previous to the introduction of the Croton water, were cisterns, wells, and the rivers on each side of the city.

19. Were the losses from fire in proportion to the number of houses much more frequent.

P.—At this period the losses from fire, in proportion to the number of houses, were much more frequent.

N. Y.—The losses by fire, since the introduction of the Croton, amount to only about half what they were the year previous.

20. What effect has the alteration had on the practice of insurance in the city? What is it in this city as compared with other cities or towns where similar provision is not made?

P.—The present system of watering the city has reduced insurance risks in the proportion of one to three upon real estate, but not upon goods, wares, and merchandize; these are considered almost as a total loss from the damage by water.

N. Y.—The insurance against fire is effected 25 per cent. lower than before the introduction of the Croton water.

21. Is water laid on in the houses of the poorer classes? If so, what is the number of rooms in the lowest classes of houses to which a separate supply is given?

P.—The poorer classes are supplied by a hydrant placed in a court or alley.

N. Y.—The water is furnished on application to all houses or other buildings; the lowest rate is for a stable with one horse, five dollars per annum.

22. Are there any public fountains or other supplies for the use of the poor? If so, how many, and at whose expense?

P.—Public fountains are placed in squares, and are always accessible to the poor and rich.

N. Y.—There are 600 free hydrants for public use, at the expense of the city, and the numbers increasing.

23. Are any and what additional arrangements as to the strength and expense of piping found necessary in private houses in consequence of the water being kept on at high pressure?

P.—There are no additional arrangements as to the strength and expense of piping in consequence of the water being kept on at high pressure. Frost is the only inconvenience in piping.

N. Y.—The $\frac{5}{8}$ -inch lead pipe is strong enough to bear the full pressure of the water let into houses.

24. Are there any arrangements in use for diminishing the pressure of the water or the ordinary force of the discharge on the smaller pipes in houses?

P.—There are no arrangements necessary for diminishing the pressure or force of the discharge on the smaller pipes in houses.

N. Y.—The brass stop-cocks allow the water to be drawn slower or faster, as desired, and, in case of need, by a stop-cock near the front of the building, the jet can be shut off.

25. What sorts and strength of pipe are in use for the larger mains and the subordinate pipes, and those in use in private houses, and what are their weights per yard?

P.—The sections of straight pipes or mains, of 20 inches diameter, are in lengths of 9 feet, which weigh each 12 cwt. 2 qrs. The sections of 6-inch pipes are of the same length, and weigh each 9* cwt. 2 qrs. Their thickness not less in any part than $\frac{1}{2}$ inch, and proved by Bramah's pump, under a pressure of 300 feet head of water. The subordinate pipes, iron, from 1 to 2 inches diameter or bore; leaden pipe $\frac{1}{2}$ to 1 inch.

N. Y.—The mains, large and small, are of iron, 36-inch to 6-inch diameter. The metal of the largest (1 inch thick) weighs 3600 lbs. for every $8\frac{1}{2}$ feet, about 1270 lbs. per yard, and smaller pipes in proportion. The service-pipes in houses, $\frac{5}{8}$ -inch lead, $8\frac{1}{4}$ lbs. per yard; over $\frac{1}{2}$ -inch, $6\frac{1}{2}$ lbs.

26. If the city were to be relaid with pipes for the public or private distribution of water, would any and what additions or alterations be made from the present plan?

P.—If the city were to be relaid with pipes, the mains would be increased in size, as well as many of the secondary pipes, and lateral pipes would be laid on each side of the mains for the supply of all the service-pipes leading into houses and yards of the city.

N. Y.—No alterations would be made if the pipes were to be relaid in the city, from present experience.

* There must be a slight mistake in this figure, the weight is excessive as compared with the 20-inch mains.

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27. What is the lowest point of the thermometer in the city in winter, and the highest in summer?

P.—The lowest point of the thermometer is 4° below zero in winter, and the highest in summer, in the shade, 102° .

N. Y.—The thermometer averages lowest in winter 15° above zero; in summer 80° above zero.

28. Which description of pipes for the distribution of the water are found to be frozen on the occurrence of severe frosts?

P.—In severe frosts all pipes laid above the surface of the earth are liable to freeze, and in many instances the bath and water-closet services are shut off.

N. Y.—None but the service-pipes in houses, where they have neglected to shut off the water at night, and occasionally a hydrant.

29. What means are adopted to meet the inconvenience?

P.—The means adopted to meet the inconvenience out of doors is by enveloping the hydrants, plugs, and pipes, with straw, blankets, sand, tan, &c.

N. Y.—The hydrants being of iron, they make a fire round to thaw them, or cover them round with straw as a preventive.

30. What depth and what description of surface soil is found to protect the pipes from the influence of the frost?

P.—The surface soil of Philadelphia is clay and loam, and the depth which is found to protect the pipes from the influence of frost is from three to four feet.

N. Y.—A depth of $4\frac{1}{2}$ feet in any soil protects the mains from freezing, and has proved fully adequate.

31. What is the depth to which pipes are usually laid in the streets?

P.—The depth to which pipes are laid in the streets is from three to four feet.

N. Y.—The pipes are laid five feet deep in the city.

32. Are the water-wheels and pumps frequently stopped by the frost, and what means are used to obviate inconvenience?

P.—The water-wheels and pumps are never stopped by the frost; they are contained in a substantial wheel-house, which is heated by stoves. The wheels are occasionally stopped by unusual tides and freshets of the river.

N. Y.—There are no wheels or pumps, and of course no inconvenience occurs from freezing.

33. What effects are perceptible on the habits of the population or the public health from the additional supplies of water as compared with the population of other towns not possessing similar advantages?

P.—Since the present abundant supply of water has been introduced into the city, we see everywhere the habits of cleanliness in

and out of doors, and the health of the people has been increased beyond comparison with that of other towns not possessing similar advantages.*

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N. Y.—The benefit of the Croton water is thought to be perceptible upon the health of the city, as compared with former years, and especially as producing temperance among the lower classes. It is too soon, however, to speak very decidedly.

34. What number of houses are supplied with water in the city and suburbs; and what is the average rate per annum?

P.—There are 25,816 houses supplied with water in the city and suburbs, and the average rate per annum is five dollars per house.

N. Y.—Average number of houses and manufactories now using the water 6000, at average expense of 14 dollars, and rapidly increasing.

35. What number of houses are without a supply of water from the water-works, and from whence do they obtain a supply?

P.—One-half of the inhabitable houses of the city and districts are supplied with water, and the other half obtain their supplies from pumps and hydrants placed in the courts, lanes, and alleys.

N. Y.—The remaining houses and buildings of the city, about 24,000, are supplied with water from public hydrants and wells formerly dug.

36. What is the amount of population of the city and suburbs, and what is the average number of inhabitants per house?

P.—The amount of population of the city and suburbs is 240,000, and the average number of inhabitants per house is from five to six. The number of houses 40,000 in the city and districts.

N. Y.—The population of New York in 1840 was 312,000.

37. What is the total number of British imperial barrels (of 36 British imperial gallons) of water supplied per annum?

P.—The total number of beer gallons of water supplied per diem = 4,000,000 for the city and districts. It has been as high as 6,000,000 gallons per diem. The British imperial gallon weighs 360 lbs. avoirdupois.

N. Y.—It is impossible now to say how much water is supplied per annum, as the hydrants and fountains are in constant use. It is supposed there cannot be any deficiency at any time.

38. Is the water always on, and have the inhabitants the power of taking a constant supply; or are they supplied with a quantity given periodically into cisterns or other receptacles, and if so, how often and for how long at a time? and is a supply given on Sundays?

* Dr. Heylem says, that the bills of mortality have lessened at least 2.0 per cent. since the introduction of the Schuylkill water.

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P.—The water is always on, and the inhabitants have the power of taking a constant supply night and day, Sundays no excepted.

N. Y.—The water is always on and in constant use.

39. What rates are charged to the different classes of houses, and what is the total amount of them? Is the charge made upon the supposed quantity of water delivered, or is it made in the form of a rate upon the rental of the houses? Is a difference made in the charge if the water is supplied to the upper floors of a house instead of being confined to the ground-floor? and is an extra charge made for the supply of water-closets?

P.—The rates are the same for all classes of houses, and the total amount of them is 150,000 dollars per annum. The charge is made upon the supposed quantity of water delivered, and not upon the rental of the houses. If the water is supplied to the upper floors of a house, it is considered as extra, and the charge is 2 dollars 50 cents. for the story, and 3 dollars for the baths &c.

N. Y.—The charges for water are noted heretofore, and is made upon houses according to capacity and employment, and upon manufacturing factories according to probable use of water. The tenant pays for the water per annum; the landlord for fixtures. The water is used over the whole premises without limit in any way, save waste.

40. What are the total available contents of all your reservoirs?

P.—The total available contents of all the reservoirs on Fairmount, by which the city is supplied, is 19,921,388 beer gallons.

N. Y.—The receiving reservoir holds 150,000,000 imperial gallons; distributing ditto, 21,000,000 ditto. The water was shut off 10 days, and found diminished in the reservoirs only one-tenth.

41. How many water-wheels and pumps are now at work?

P.—There are now at work eight water-wheels and pumps.*

N. Y.—There are no pumps or water-wheels connected with the waterworks.

42. How many tenants were supplied in the first year after the opening of the works, and how many have been added each year?

P.—The first year the water-rents were 500 dollars, and the present year yields upwards of 150,000 dollars per annum.

N. Y.—About 3000 houses supplied first year, and 300 since.

43. How many officers, turncocks, and other men are employed?

P.—There are now in employ for the city and the works :

* For a complete and exact plan, elevations, and sections of the whole machinery, such as mill-wheels, pumps, mains, dams, and reservoirs, I have the honor to refer you to the first and second numbers of the "Public Works of the United States," edited by Strickland, Campbell, and Gill; and published in London by John Weale, Architectural Library, High Holborn.

Fairmount, turncocks and other men, viz., in all ten men. One Philadelphia and New York, U. S.
at 2 dollars 50 cents.; one at 1 dollar 75 cents.; three at 1 dollar 50 cents.; four at 1 dollar 25 cents.; and one at 1 dollar per day.

N. Y.—The following are the officers and other men employed, with a statement of their salaries:—

	Dollars.
President of the Aqueduct Board	2000
Superintendent of the works	1000
Water Purveyor, and Assistant to Superintendent	1000
Register of Rents	800
Clerk to Superintendent's Department	900
Two Assistant-Clerks	500 and 400
Superintendent of Tapping, to examine the inser- tions made in the water-pipes	600
Messenger in the Office	313

One Keeper of the Upper Reservoir, 730 dollars per annum; one Assistant, at 365 dollars; one Keeper of the Lower Reservoir, at 730 dollars; one Foreman of the Aqueduct Yard, 782 dollars; two workmen at ditto, from 1 dollar to 1 dollar 25 cents. per day. There is, besides, a company of men engaged in making repairs, &c., including two foremen, at 2 dollars each per day; and other labourers at from 1 dollar 50 cents. to 1 dollar per day: in all about 20 persons.

44. What is the annual cost of carrying on the works, and how much is expended annually for laying pipes and extending your works?

P.—The annual cost of carrying on the works are as follows, viz.:—

	Dollars.
Superintendent	2000
Assistant-Superintendent	300
Register	1500
Messenger	500
Contingencies	500
	<hr/> 4800

And the average cost per annum of extending the works during a term of 21 years is 43,000 dollars; the total cost of all pipes laid down in the city and districts, since the year 1822, 900,000 dollars.

N. Y.—No satisfactory answer can be given to this question, as the works have been so recently established.

45. At fires are fire-engines employed, or is the supply obtained by attaching the hose and nozzle directly to the pipes?

P.—At fires fire-engines are employed, as well as a supply obtained by attaching the hose and nozzle directly to the fire-plugs, which are placed on the edge of the kerb-stone.

Philadelphia and
New York, U. S.

N. Y.—Engines still continue to be used partially, but hose will eventually supersede their use.

46. What is the usual or average bore of the house-pipes, and of what material are they?

P.—The house or service-pipes are of lead, and the average bore three-quarters of an inch.

N. Y.—In houses they use lead pipes, five-eighths of an inch.

47. Are there any heights above the city, or other natural advantages, which have been used in the formation of the waterworks, or is the system equally applicable to towns situated in level districts?

P.—There are several heights above the plane of the city, and above that of Fairmount; but Fairmount is now only used at the head of the city's works, and our system is not equally applicable to cities situated in level districts, unless elevated reservoirs or basins are constructed artificially. Philadelphia is situated in a level district, very much like that of the City of London, and the Thames at Windsor is just such a river as the Schuylkill; but she has the natural advantage of a mount for her reservoirs, not more than two miles distant from the centre of population.

N. Y.—There are various heights about the city, but are of no value to the waterworks, as the Croton river is higher than any of them.

Mr. R. Anderton, **MR. ROBERT ANDERTON, MANAGER of the PRESTON WATERWORKS,**
On the Constant Supply of Water under High Pressure.

ARE you manager to the Preston Waterworks Company?—Yes, I am.

How long have these works been established?—Since 1832; the Act was obtained in that year, although the works did not come into operation for two years after.

How many houses are there in Preston?—About 10,000.

Of these how many are supplied with water by your Company?—Upwards of 5300; we increase our tenants at the rate of about 400 annually. Our lowest charge for water is 5s. 6d. per annum when the landlord pays, and is a large cottage owner. In cases in which there are only one or two houses, the charge is 9s. per annum. But this charge is really less than it appears, because we have no tanks. If these had been required, our Company would have got on much more slowly than it has done, for the tenants could not have borne the increased expense.

Then the water is always on at high pressure?—Yes, it is; the highest pressure is 160 feet, and the lowest 36 feet; the average pressure throughout the town I find to be 90 feet. This pressure is kept on all pipes of every description, and at all times.

Does this pressure render it necessary to have larger and stronger mains and service-pipes than those used where the water

is not kept at high pressure?—Quite the contrary, because the water being constantly on, and not coming at intervals, a smaller pipe is sufficient for delivery, and the pipes are not strained by a sudden gush of water. We never have had a pipe which has burst from the pressure of the water; but we test them beforehand to bear the pressure of 300 feet. The weights of the pipes used by us are as follows:—

$\frac{1}{2}$ inch lead pipe	6 lbs. to the yard.
$\frac{3}{4}$ " "	9 "
1 " "	12 "
3 inch iron pipe	44 "

and other diameters in the same proportion.

What is the tenant's charge for a communication-pipe?—The Company takes the pipe up to the wall of the tenement to be supplied. The tenant's charge for fixing the pipe from the wall averages from 5s. 6d. to 6s. We guarantee to keep in repair all our own pipes.

It has been stated that, taking one house with another, the cost of tanks is about 2l. per tenement, so that the tenants' charges upon the 5300 houses supplied by you, in the event of the necessity of supplying them with tanks, and their necessary appurtenances of balls, &c., would have been at least 10,600l. instead of 1590l. as by your present arrangements?—Exactly so; or, in other words, the charge of water to the tenant would have been increased to 11s. 2d. instead of 9s., as by the present arrangement. The additional cost must have always remained the same; the lowest charge, for example, instead of being 5s. 6d., would have been to the tenant 7s. 8d.

Are you of opinion that this additional annual cost of 2s. 2d. for each tenement would have operated prejudicially by preventing the increase of tenants to the Company?—Undoubtedly so, especially in the case of large owners. For example, Mr. Smith has 80 cottages into which he has taken water: the cost of taking in water, according to our present arrangements, is 24l. for this number; but if tanks, balls, &c., had to be used, the cost would be 160l., a sum which a cottage owner could not, in all probability, conveniently afford, and in this case, entailing upon Mr. Smith an actual annual increase of expense of at least 8l. per annum for water to his cottages.

It has been stated that the constant supply of water in the pipes subject Companies to a considerable waste; do you find by your experience that this is really the case?—Quite the reverse; I think the constant supply is a means of saving water. We very seldom indeed receive any complaints of an unnecessary waste of water, and our men are very active in searching out grievances of this kind. The fact is, that our high pressure would render a running tap a great nuisance, from the noise it makes. Our actual consumption of water is 76 gallons per house, but this includes all

Mr. R. Anderton. the large consumers, of which we have a great many in mills and railways. The average consumption in tenements of the labouring class is 45 gallons daily.

It has been stated in evidence that it would be impracticable to lay on water into the houses of the lowest classes by means of leaden pipes, as these would assuredly be stolen; do you find thefts of this kind to be of frequent occurrence?—We do not. Within the last two years there have only been three cases of theft of this kind, amounting altogether to about 15s. worth of lead stolen. I am quite sure there have not been any other cases of this kind; in all the three, the thieves were wholly unconnected with the premises; and in two of them the houses were untenanted when the thefts took place. In this town there are abundant facilities for such thefts, if they were at all likely to occur, for the pipes have been badly laid down and are much exposed. The theft would be rather a dangerous one too, for the thief would get well watered, and the noise of the water would soon betray him.

Do you find that your poorer tenants are willing to pay the water-rents?—In general, very willing. In fact, I have had many applications from tenants of houses, in which water is not laid on, to speak to their landlords to introduce the water, as they were quite willing to pay rent for it. We had a few public taps at a cheap rate, each to serve a number of houses, as they have in Manchester, but we found they were productive of so much mischief to the poor themselves, when they congregated round the taps, and so great a quantity of water was stolen from them, that our directors have given orders that they should be discontinued. I may state, that we lose very little indeed in our collection of water-rents.

How do the people who are not your tenants obtain water?—There are still one or two water-carts which charge one halfpenny per can, containing about three gallons; so that if the people who get water in this way used as much water as they should do, judging by the experience of our tenants, the water would cost in their case 5d. daily, whereas, by our charge, it amounts only to one farthing. But such people do not use a proper quantity of water, and, consequently, both their houses and persons are very dirty. There are some pumps in the town, but the labour and expense of fetching water from them is so considerable that they are gradually getting out of use.

What capital has the Company invested in the works?—About 36,000*l.*, or 2*l.* for each individual supplied, but estimating the expense of management as an element of the calculations, it would amount altogether to 60,000*l.*

Then you estimate the expense of management at 1200*l.* annually?—Yes, it is very nearly so.

If you were to include as tenants all the houses in the town,

then you could decrease the amount of charge, because the capital would be divided over more individuals?—Certainly, we could make a very material decrease, for the increased expense of working a more extended supply would be nothing like the rental from an increased demand.

How many turncocks do you employ?—Only one; he is sufficient for all purposes.

Have you no other force?—We have five men who work for us in laying and fitting up pipes. We do not allow the plumbers to do any work for us. In addition to this, there are two collectors, and a boy in the office.

Then, in fact, one man is sufficient to regulate your cocks and valves?—Quite sufficient, and he has time to spare for other work.

You state that you do not employ plumbers; do you refer to the interior fittings of a house as well as to the exterior?—Yes, we do the whole work ourselves. We found that the plumbers did not do their work uniformly, and charged high, and as it is important to have the work well done when the water is at high pressure, we took the whole into our own hands.

By this arrangement the charge for the introduction of water into a house is materially diminished?—Very materially so, at least 20 per cent. As we do not make a profit upon the fittings, we can let our tenants have them at prime cost.

This also has contributed to the rapid increase of the number of your tenants?—Without doubt it has.

If the water-closet system were introduced, and a check by a peculiar tap made upon the unnecessary waste of water, would the additional charge of water to the tenant be considerable?—I cannot answer that question positively, but I should think not.

The water being constantly on in the mains is, of course, at all times ready for the extinction of fire?—It is, and has been found to be of great service from its high pressure.

Does the use of water during the day diminish the pressure to a material extent?—I have made the following experiments, to ascertain this point:—

Result of Experiments made on the 8th March, 1844, to ascertain the Height that a $\frac{3}{4}$ -Inch Jet of Water will rise from the 6-Inch Mains of the Preston Water Company.

At a Pressure of 110 Feet.

Day.

Night.

Height, 57 feet = 78 gallons per minute.

64 feet = 90 gallons per minute.

With Two Jets of $\frac{3}{4}$ -Inch at once.

Height, 56 feet = 78 gallons per minute.

62 feet = 87 gallons per minute.

At a Pressure of 46 Feet.

Height, 24 feet = 30 gallons per minute.

28 feet = 35 gallons per minute.

With Two Jets attached.

Height, 20 feet = 29 gallons per minute.

25 feet = 30 gallons per minute.

Mr. R. Anderton.

You can throw, and do throw in case of fire, by means of a hose, water over the highest building?—In some cases we do. The average height during the day to which water can be thrown by this means is 46 feet. In fact, the hose is found so useful that the owners of mills are now introducing water into every story, a plug being placed in each, with hose ready to put on in case of fire. In Mr. Rodgett's mill, for instance, there were fires on two occasions, and in neither case has damage of any consequence ensued, as the hose was instantly screwed on and the fire put out. The watchman can manage the hose quite well, and the owners are now so confident of the success of the plan that they do not insure the buildings. The owners of other mills, seeing the good effects of the hose, have also been meditating to give up their insurances, feeling confidence in the increased safety which the plug affords.

It has been stated that engines are not used in Preston in case of fire, but that the hose is merely screwed on to a plug, and that the water is by this means thrown upon the fire?—The engines are generally taken out; but, as the firemen prefer the hose, they do not use the engines.

At what distances are the fire-plugs from each other?—Where we have mains, every 100 yards through the whole town.

What is the expense of laying down plugs?—We have plugs of a peculiar and very superior form; their cost is 2*l.* each; formerly they were laid down at 1*l.* each, but these have been taken up and the new plugs substituted.

Is the distance of 100 yards sufficient?—The distance is too great to be of service to every house; they should only be 50 yards distant; but, in the event of this being done, the public, and not the water company, should bear the expense.

According to your rate of 2*l.* per plug, supposing them to be placed at intervals of 50 yards, making each house not further distant than 25 yards, the original cost to each house of the smallest class would not be above 4*d.*, or about 5*d.* of annual charge on each house for the increased security and protection against losses by fire?—That is the correct way of viewing the question.

What is the expense of fitting up a warehouse with plugs in each story?—About 25*l.* to 30*l.* for a warehouse of five stories. We charge a guinea annually for the privilege; so that the total annual cost is about two guineas.

It is stated that the insurance even of the smallest class of warehouses amounts to 20*l.*, and of many to 500*l.* or 600*l.*; so that for 2*l.* they receive such additional security that some of the proprietors of such property have thought of discontinuing their insurance?—That is the fact.

You have been present during the experiments of washing the streets with water?—I was; but the pavement on which we tried it was very inconvenient; and if it were done on square set

stones, or wood pavements, I do not doubt that it could be done at one half the expense we estimated it at. This of course refers to places where the supply of water will allow it. Mr. R. Anderton.

Are you extending your waterworks?—We have about 53,000,000 of gallons' capacity in our reservoirs, and we are about to build a reservoir capable of containing 30,000,000 more. We have plenty of water if we had the means to collect it.

From your statements it results that the extension of water to every house in the town could be effected at one-sixth the cost of the necessary expenditure, where the water is not constantly on, and where tanks with their necessary appurtenances have to be used?—That, or rather less, for various reasons; at all events, the cost would certainly not be more than one-sixth.

You have read Mr. Hawksley's evidence?—Yes, with great attention.

Does your experience enable you to confirm his views?—As far as I can judge, he is quite correct; when he refers to water, I entirely agree with him.

Do you agree with that portion of his evidence in which he states that the effect of two rival companies in a small town will be to increase the price of water to that town?—Decidedly so; for, in such a case there must be two capitals invested, and, therefore, two interests must be paid on that capital by the public.

In such an important article as water, it is necessary that the public should be protected from inefficient supply, or overcharge; are you of opinion that a central national authority, to which any complaint might be referred, would be much better than the impolitic check from the interested rivalry of two separate companies?—Unquestionably so, both as regards the company and the public. To take the instance of our own company, we might be injured by a rival company, but the public would not be gainers, for the chances are that the companies, finding neither profitable, would unite, and thus increase the burdens on the public. But, in the case of a disinterested national authority, there would be a check upon the encroachments of a company, and the change, if any, must be in favour of the public.

MR. JOHN SMITH,

Mr. John Smith.

On the Supply of Water to the Houses of the Poor.

ARE you a large owner of cottage property in Preston?—I have about 80 or 90 cottages, besides other property.

Are these cottages generally inhabited by the poorer classes?—By labourers and their families. They pay from 2s. to 2s. 3d. per week; but this frees them from all other charges for taxes and water.

Mr. John Smith.

There is water introduced into all the houses?—Yes, into every house. I have contracted with the Waterworks Company at the rate of 5s. 6d. per cottage, whether occupied or not. I do not charge any separate rent for it, as I consider that I am paid by the increased demand for my houses.

Since you introduced water into your houses have they let better?—Yes, very much better. I formerly had 40 or 50 houses empty; now I have not more than one. Perhaps this is not altogether due to the water, but that I am sure is the great inducement. I have not increased the rent since I took in water; they agreed to pay me 2d. per week more for the advantage of the water; but I have never charged that sum, as I find the increased demand pays me.

If you had been obliged to use water-tanks or cisterns to each house, with the usual appurtenances of balls and cocks, would you have ventured on the speculation of supplying each house?—Most unquestionably not; it would never have been paid me; I could not have thought of it; the original outlay to myself would have been considerable, and my tenants could not easily have remunerated me for the outlay.

Then it was because the water is constantly on in the pipes, and therefore the small expense of laying it on, that induced you to supply your houses with water?—It was indeed, and the convenience to my tenants.

Have you any neighbouring cottage owners who have not laid on water to their houses?—There is one close by: the consequence was, that many of his tenants left him and came over to me immediately that I laid on water, although his houses are rather better than mine in other respects.

Have you noticed any difference in the cleanliness of your tenants?—I have no doubt of it, but I cannot be positive, as I do not go much amongst them. I have seen, however, when they came to me, that their persons are much more cleanly.

Have you any common sewer in your property?—No; but I applied lately to have a sewer in the main street, and I promised to contribute anything which the Commissioners might think fair. There are many owners in the street, but I know none but myself who would contribute to the expense. If there was a main sewer, I would gladly, at my own cost, make branches from every house into it.

Would you object to contribute to the making of the main sewer, according to the frontage of your property, if the neighbouring owners did so also?—Not at all; I should be delighted to do so.

And would you prefer to pay the cost all at once, or in equal annual instalments with interest?—You ought to give me the option: perhaps, as far as regards myself, I would pay

it off at once. There are some cottage owners here who have their whole support from the rents of their cottage property. To them it would be a great boon to have the power of paying the cost of improvements by instalments. A very intimate friend of mine, an old lady in Manchester, had the front of her house sewered and paved; it swallowed up the whole rent for nearly two years; she had only the life interest of the property; she died at the end of the two years, and she often complained to me how severely this sudden call distressed her.

Mr. John Smith.

Do you think that, if this option was given, the cottage-owners would object to the construction of main sewers, the connection of their houses by private drains with these sewers, and the like improvements?—The principal cottage-owners would not at all object, I am sure, if the instalments were distributed over a period commensurate with the number of years' value of the property. They would be very glad to have the improvements effected. It would make their property let better. For example, from want of drainage, I am obliged to sink dry wells into my cellar to allow the water of the house to run into the subsoil; these wells cost me 3*l.* or 4*l.*; a main drain connected with a sewer would not cost me 20*s.*

How long have you known Preston?—I have been here 47 years.

At the commencement of that period, was the drainage very bad?—There was none at all. About 30 years ago, in a street off the one in which we are, I recollect a woman being drowned in the gutter or ditch running by the side. Then we began to think it was worth while draining streets. That street is not yet all drained, because one proprietor will not allow the whole to be drained; for he says that it will make too good a road to a neighbour's property, and improve that too much. Although it would be done at no expense to him, still he thinks his private interest affected, and he will not allow the improvement to be made.

III.

THE SEWERS OF THE METROPOLIS.

Samuel Mills,
Esq., and Mr.
John Roe.

SAMUEL MILLS, Esq., and MR. JOHN ROE, examined.

(To Mr. *Roe*). You are the surveyor of the Holborn and Finsbury district of the Commissioners of Sewers?—Yes.

How long have you been employed in that capacity?—As surveyor, about five years; but I have been in the employment of the commission 12 years.

Before you came into that employment, had you been engaged in any works bearing on the construction of sewers or drainage generally?—I had on canals, turnpike-roads, and railways, and drainage connected with those works.

Your attention had been particularly directed to that description of work?—Since I have been in the employment of the commission it has entirely.

Have any alterations been introduced, as to the construction of the sewers, since you became surveyor to the Commissioners?—There have been some alterations made.

Will you explain any improvements which have been made in their construction?—We trapped the gully holes and shoots, which carry the surface water from the roads.

Has the flushing system been introduced?—It has.

Will you give an account of the construction of the sewers and the improvements which have been made in them?—The sewers, at the time I became surveyor, were constructed with upright side walls. The sewer, called the first-sized sewer, had 14-inch side walls, was five feet in height and three in width; the second-sized sewer was four feet six in height, and two feet six in width. Soon after I became surveyor, a sewer of the first size, with 14-inch side walls, was built in a clay ground at the side of a hill, by a very good bricklayer, and a very respectable contractor; but, though that had every advantage of execution and material, the side walls, being upright, were not sufficiently strong; the ground forced in the upper side wall of the sewer for a length of 300 feet. After that, I proposed to the Commissioners that they should adopt a curved side wall, instead of an upright side wall.

Were the bottoms of the old drains semicircular?—Yes.

Did you use the common brick for the sides?—The common stock brick. At the same time I suggested to the Commissioners, that by adopting curved side walls we should do away with four

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inches of the 14-inch side walls, which would yet be stronger than before. The Commissioners considering that an advantage, have adopted the oval sewer, and decreased the quantity of material.

When the walls were upright, it was necessary to give an increased thickness to them to obtain the requisite strength; but by making that curve on the sides, the shape being an arch to a certain extent, renders that thickness unnecessary?—Yes.

What is the difference of the cost of those two sewers?—The difference of cost is 3*s.* a-foot in the larger size; in the other, or second size, the cost remains about the same, as it had only a nine-inch wall before. There are many cross streets in the district where there are but few houses to drain, where, if a long length of sewer was built, it would become very expensive to those few houses. Curved-formed sewers, I considered, would enable the Commissioners to afford a sewer for those cross streets of a much cheaper description, and I suggested that they should adopt a sewer half brick in thickness, built of blocks of brickwork and cement all round, and that that would be sufficiently strong, if made with radiated bricks, with blocks in cement. That suggestion the Commissioners have adopted, and that enables them to afford the public a saving of 5*s.* a foot run upon the second-sized sewers.

Of what size are those?—They have the same capacity as the second-sized sewers.

What was the difference of the expense between using the radiated bricks and the common stock bricks in the construction of sewers?—The brickmaker charged 8*s.* a thousand more for the radiated stock than the common stock; the common stock is 32*s.*; he charges 2*l.* for the radiated bricks; but if there was a competition for radiated bricks, they would cost very little more than the common brick.

What is the difference in the expense in building a sewer with the radiated brick as compared with the common brick?—The difference consists in the radiated brick being used with less materials, as they fill up the space which would otherwise be occupied by cement; therefore in reality there is no extra cost, for it saves so much cement.

Have you made any alterations or improvements in the mode of connecting one sewer with another, the smaller with the main sewer, for instance?—There has been an improvement effected in that respect. The general mode was, to connect them at right angles, or nearly so. The objections to that I found to be, that there were great accumulations in the sewers; the water flowing from the collateral sewer retarded the column of the water in the main sewer, and thus caused an obstruction by which the filth and deposit, which would otherwise have passed off into the main drain, was retarded and accumulated at that point and above it. Some of the original sewers are made with flat bottoms, and

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there are a great many of the older sewers in these divisions with flat bottoms still in use.

When there is a new district to be built over, which of course will require drainage, what are the rules and regulations with regard to carrying up a sewer from the main sewer; have the Commissioners the power to compel the builder to carry a sewer? —(Mr. *Mills*.) They have not; the old laws of sewers only authorizes the maintaining of sewers.

It does not enable the Commissioners to insist on new sewers being made in such places?—Certainly not. On the Canonbury estate, which was lately let for building, provision was made for the sewage, without making sewers in the lines of the public streets, by receptacles for sewage, without any communication from them. The Foundling Hospital estate was leased for the builders to make the sewers, the Commissioners having no control over them. When they were made, these persons applied to the Commissioners for leave to communicate with the existing sewers; the Commissioners then exercised their authority by saying, “No; these sewers are inadequately built; therefore we will not suffer them to communicate.” That is the only power the Commissioners can exercise, namely, not suffering the communication. The inhabitants of course, applied for relief, and ultimately the directors of the Foundling Hospital came to the Commissioners. The answer was, “Gentlemen, you have suffered these sewers to be made by builders in a very improper way; therefore we cannot suffer them to communicate, for we shall have them to rebuild in the course of two or three years.” The question then was, what was to be done? It was at length agreed that the whole of the sewers on the Foundling estate should be surveyed; those that were good should be allowed to stand, and the Commissioners would take to them; those that were not, should be rebuilt. That was the condition of the communication taking place. The Foundling estate adopted that method, and the whole of that estate is now drained as well as any other part of the division.

When once you admit a range of collateral sewers to communicate with you, you undertake the repairs?—I am afraid that we are bound; we have no alternative.

Suppose sewers are constructed on an estate, and application is made to the Commissioners for leave to communicate with the main sewer, and leave is granted, are those sewers in future kept in repair and in efficiency by the Commissioners?—When persons apply to the Commissioners before the sewers are built they must sign a printed form, wherein they engage to build them according to the rules of the Commission; and after they are built, they are surveyed before they are recognized by the Commissioners; but when once so allowed, the Commissioners ever after keep them in repair.

Where they have not previously applied to the Commissioners, but have built new sewers, and afterwards applied to the Commissioners for leave to communicate with the main sewer, what is the course?—Their communication without permission is a trespass; they are liable to be fined any sum of money the Commissioners think fit. In a neighbouring Commission to bring the parties to terms, it was proposed to fine them 1000*l.*, and that alarmed them (for that fine would have been returned into the Exchequer, and must have been paid); they came to the Board, and, on their uniting the sewers in a proper way, the Commissioners remitted the fine.

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Will you inform the Commissioners what you consider would be the best mode for the construction of sewers in places anciently built on, or those newly built on?—It was provided in the Bill brought into the House of Lords the last session that no houses should be built without sewers being provided, under the authority and according to the regulations of the Commissioners (that is one of the defects in the original Act, that Act providing only for the maintenance of the sewers); that power is certainly a very desirable one to be obtained.

You think it better the law should be altered to that extent that the construction of any new sewer in any new district that is to be built on, or one built on requiring drainage, should be put entirely under the Commissioners, and that it should not be in the power of the owners of the estates to construct those sewers, unless in conformity to the regulations of the Commissioners?—Certainly.

Would you, in doing that, throw the whole of the expense in the first instance on the Commissioners, and call upon the owners of estates to pay, or the owners of houses to pay up the outlay of capital by instalments; or would you, in the first instance, make the owners of the houses pay the expense at the time of the execution of the work?—Where pasture or other ground becomes so valuable as to become building ground, that instead of being worth 5*l.* or 6*l.* an acre, it is valued by the foot, it can be no hardship to the person, who is thus increasing the value of his estate, to require him to be at the expense of building the sewers. The plan on the Duke of Bedford's estate is this: he builds the sewers in the lines of the street, which are laid out; the ground is then let, subject to the cost of the sewer (or at least a moiety of it being paid for, the houses being built on each side); when the house is covered in, the party applies for a lease; the lease is granted on payment for the portion of the sewer in front of the house: that seems the best mode, and that has hitherto proved the most effectual.

The owner of the land, or his sub-tenants, pay the whole expense?—Yes.

And the sewers are laid down under your direction?—Yes. The agent of the Duke lays down the lines of the sewers; the execution of them is done under our direction, and the builders pay

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for them on their obtaining the lease; so that when the builder has found a purchaser for his house, and wants a lease, he is enabled to pay the sum apportioned without an additional advance of capital.

The whole expense of the construction of the sewer is paid either by the owner of the ground or his lessee, and the sewer is constructed under the direction of the Commissioners?—Yes.

So as to ensure its being built in conformity with your regulations?—Yes. In our commission we have received many hundred pounds from the Duke of Bedford for sewers on his estate.

You consider that a power to carry out that agreement would be advisable?—Yes, most important.

How would it answer for the smaller description of houses, where a builder takes a piece of ground, 200 or 300 feet long, and builds a lower class of house?—The owner of the ground must make his terms with the person who takes the ground, as the sewer is to be built under the regulations of the Commissioners; and if the Commissioners undertake to build the sewer at the request of the lessee, the lessee will get the ground for less than if it is built in the first instance, as is the case sometimes.

Would it not be best to give the Commissioners authority to have it done, and to make a rate to pay for it, by which the Commissioners would be indemnified?—There would be no objection to an enactment being made for that purpose. Following up that, perhaps, you would next consider what should be done. Where a street of old houses exists, and where there are new houses, there is a sort of discretion exercised by the Commissioners: if there is a street which has been built 100 years, or 50 years, they would say to the parties who came forward, "This sewer will cost 1500*l.*; you must subscribe 300*l.*;" if it has been built within 20 years, they would say you must subscribe more. I think this last year the commission has received under those circumstances from 1000*l.* to 1500*l.* from old lanes and streets where there were no sewers. Chancery-lane is a recent instance; the benchers of Lincoln's Inn have been building a new hall; they found they had not a sufficient drainage; they applied to the Commissioners, who said, "We'll give you a drainage, but to do it we must deepen the sewer in Chancery-lane; it would not be reasonable that the inhabitants of the whole division should pay for deepening a sewer for your convenience; you must contribute towards the expense." They saw it was necessary that they should have it, and that they ought to pay a part; and they have paid 350*l.* towards it, and the sewer has been deepened.

Then it is necessary for the parties to agree to what you consider fair terms?—Yes.

If parties disagree, does not that prevent the improvement being made?—Completely.

Is it not desirable, therefore, that there should be power given to

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allow the Commissioners to require a sewer to be made wherever they see it to be necessary?—Certainly, and that was one of the provisions in the Bill brought into Parliament last session.

Supposing, in consequence of such improvements, a considerable cost is requisite in the case of the owners of small tenements, as the cost thrown upon them would be considerable at first, would it not be a good provision that some plan should be adopted, by which that could be extended over a series of years, eight, ten, or twelve, so that the expense should be paid by instalments?—I think that a plan might be arranged for that purpose with comparatively little inconvenience; the sewer rate is a rate upon the land, not upon the tenant; the difficulty is with the beneficial leaseholder.

(*To Mr. Roe.*) Will you explain the system of cleansing the sewers, as at present practised, and show the advantages to be derived from it over the former mode of cleansing?—Under the former system, when complaints came to the office, the sewer was examined to ascertain the cause of the stoppage, and if it was in the sewer it was ordered to be cleansed; sometimes filth and soil had accumulated to 18 inches, sometimes to two feet, sometimes to three, and even to four feet, when the complaint has come; in that case the houses situated on rather elevated ground would not feel the obstruction to the sewer so soon as those which were on a lower level or with deep basements. To cleanse the sewers the Commissioners caused man-holes to be placed, to prevent the necessity of breaking the arch of the sewer; but as a great portion of the sewers had no man-holes, the arch as well as the street was obliged to be broken open, and the soil raised to the surface, and afterwards carted away.

Does that cause a great nuisance?—A very great nuisance; the first nuisance was to the inhabitants, who complained that their houses were overflowed, and that probably for some time before they came to the office; sometimes when we went we found that they had been annoyed perhaps for months; they had not conceived it was by the stoppage in the sewers; the next inconvenience was in the raising of the soil, it being emptied on the street, and allowed to remain for some time; oftentimes it filled the kennels, and annoyed the passer by, till it was removed.

What was the cost per cubic yard for removing?—For removing the soil from the sewers which had man-holes, it was 6*s.* 10*d.* per cubic yard; from those without the advantage of man-holes, 11*s.* per cubic yard. That extra price was considered as including the expense of breaking open the arch, and making it good again.

Where was it deposited?—In lay-stalls and other places. (*Mr. Mills.*) There is a public lay-stall for the City at the bottom of St. Andrew's Hill; but as London has become extended, the difficulty of depositing the soil has become greater.

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The lay-stall was of itself an inconvenience to the neighbourhood?
——Yes; the soil has been obliged to be carried further and further.

Is that lay-stall at St. Andrew's Hill entirely abolished?——It is not abolished; but the evil is remedied by the barges taking it away, and that also applies to the northern parts of the town. Where the Regent's Canal passes there are also two or three, and in Paddington, and the barges carry it away for manure. There is no difficulty in finding purchasers for it among the farmers, the difficulty is where to lay it for the time; but the Paddington and Regent's Canal have afforded facilities by having lay-stalls on their banks or wharfs.

Would it not be possible to have barges alongside always for receiving it, so that it should never be laid on the ground?——There would be a difficulty in shooting it out of the carts; but it never lies beyond a circumscribed period. (Mr. Roe.) Another nuisance, which was considered a great one, was its affecting the health of the men concerned in removing the stuff. I have known a man, in opening a small sewer in White Horse-court, Cow Cross, the moment he had opened it and arrived at the deposit, taken ill immediately and obliged to go home, and he was ill for a month with fever. The men, in many cases, have been afflicted with dysentery. Having observed that there was a current of water through the sewers in many parts, though not sufficient to remove all the soil, I conceived it might be available for keeping the sewers washed out, when once cleansed.

Will you read the paper put into your hands, and state whether that is conformable to the result of your inquiries?——

Principles of the Flushing of Sewers, stated from PROFESSOR ROBISON'S "Treatise on Rivers."

It might occur to some minds, as an objection to the practicability of the proposed plan, that although the system of floating away by water might be well adapted for the removal of all organic—that is, animal and vegetable—refuse, still that it could not be applied for scouring away such substances as coarse sand, gravel, and clay.

Practice, however, proves that it is only necessary to increase the velocity of the water in order to separate and lift the particles of these minerals, and to maintain them in suspension.

It has been stated, as the result of experiment, by Professor Robinson, in his excellent "Treatise on Rivers," that a velocity at the bottom of a stream

of 3 inches in a second will separate and lift up particles of . .		fine clay.
6 inches	ditto	ditto fine sand.
8 inches	ditto	ditto coarse sand.
12 inches in a second will sweep along and lift up particles of		fine gravel.
24 inches	ditto	ditto . . . gravel 1 inch diameter.
and 36 inches	ditto	ditto . . . angular stone of the size of an egg.

It appears from these experiments, therefore, that a velocity of six inches in a second would be sufficient for scouring away all the usual sediment, and that a velocity of one foot in a second would sweep away fine gravel

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A popular idea may be formed of this velocity of one foot per second, when it is considered that it amounts to 3,600 feet in the hour, and that the walking pace of a man is about 20,000 feet in the same time, which is almost six feet in a second.

The usual velocity of the periphery of a water-wheel is also about six feet in a second.

You have made experiments on this subject?——Yes; the results of which I have drawn up, and are as follows:—

I have noticed some of the evils occasioned by the prevalent method of sewer cleansing, such as the allowing of foul deposit to accumulate and remain for years in a state of fermentation in the sewers beneath the streets; the annoyance and expense caused by private drains being choked with the filth accumulated in the sewers; the breaking up the streets and roads to reach the sewers to remove the foul deposit; the raising from the sewers, and laying out of the offensive matter on the surface to be carted away; men working day after day beneath a sewer knee-deep in decomposed animal and vegetable matter.

The consideration of these evils and their consequences led to a desire to endeavour to remove the accumulations in a less offensive manner, and to construct the sewers on principles calculated to lessen the causes of the formation of deposit.

The Holborn and Finsbury divisions are peculiarly situated, having no immediate communication with the river Thames. The waters from these divisions have to pass through one or other of the adjoining districts; namely, the City of London, the Tower Hamlets, or the City of Westminster, before reaching the river. The sewers of the Holborn and Finsbury divisions have therefore, of necessity, been adapted to such outlets as the other districts respectively afforded; and these having formerly been put in without due regard to an extended drainage, the sewers of these divisions have not had the benefit of the best fall that could have been obtained. Of late years many of the outlets have been lowered in the adjoining districts; but to alter the existing sewers of these divisions to the amended levels would require the rebuilding of about 323,766 feet of sewer, at an expense of nearly a quarter of a million sterling. The paper returned by Messrs. Stable and Lush shows how much the levels have been lowered in the last 10 years.

Levels were taken to ascertain whether such fall could be given to the sewers, if rebuilt at the lowest level, as would secure the passing of the foul matter with the common run of water; but the utmost that could be obtained would be the cleansing of one half the sewers, while the remaining portion would still require artificial aid. The cost of lowering the sewers to obtain this partial relief would be about a quarter of a million sterling, as before stated.

Although the ordinary current of water, which passes along the covered sewers (in some constant, in others periodical) in these divisions, in numerous cases does not prevent deposit from accumulating, yet I conceived it might be made available for that purpose.

The data on which to calculate with some precision what velocity of water is required to transport given kinds of matter in suspension is very imperfect. The paper containing a statement of velocity is compiled from the experience of Du Berat and others. Taking it, as affording the best approximation that we can at present find, a series of experiments were commenced in order to ascertain what velocity could be obtained in the sewers; and it appeared that deposit might be removed, by the means of dams placed in certain situations to collect heads of water, at less expense than by the usual method.

Another series of experiments were made for the purpose of endeavouring to ascertain the proportion of decomposed animal and vegetable

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matter, and detritus from the roads, carried through the sewers to the river Thames by the common run of water. Several square boxes were constructed to hold one cubic foot of water each. These were filled with water from different sewers. After allowing the turbid water to clear itself by precipitation, I ascertained the relative amount of the precipitate. The following were some of the results:—

Sewers.	Proportion of decomposed Animal and Vegetable Matter and Detritus from Streets and Roads, held in Mechanical Suspension.	Remarks.
River Fleet Sewer, near outlet.	1 in 96.	The run of water was 10 inches in depth, and 10 in width, having an average velocity of 83·47 feet per minute, passing 692·8 cube feet of water per minute; the matter conveyed being 7·21 cube feet per minute, or 103,660 cube yards per annum.

The River Fleet sewer conveys the drainage of 4,444 acres of surface, or about four-sevenths of the surface of these divisions. That great quantities, in addition to the above, is carried away by the force of water in rainy weather is certain; allowing this source, and the remaining three-sevenths of the district to only equal the discharge by the River Fleet sewer, there appears to be a quantity of upwards of 200,000 cube yards of matter carried to the Thames per annum from these divisions in mechanical suspension, and by the force of velocity, weight, and volume of water. The quantity of deposit, taken from the sewers in these divisions by the prevalent method of cleansing, has averaged about 2,200 cube yards per annum; therefore the quantity flushed to the Thames by the flushing apparatus is as 1 to 100 of that which was already conveyed by the force of water.

Some experiments were made with the water taken from the sewer, at the top and bottom of a long street, having numerous courts and alleys on each side. The following is the result:—

At the upper end of the street, matter held by the water in mechanical suspension	1 in 96
At the lower end of the street.	1 in 39

In another main sewer, where the run of water is always sufficient to keep it clear from deposit, the proportion was 1 in 80, composed of equal proportions of decomposed animal and vegetable matter, and silt or detritus from roads and streets. In another main line of sewer kept always free from deposit in a similar manner, the proportion was 1 in 66, the proportion of decomposed animal and vegetable matter being greatest.

The next experiments were made with the intention of ascertaining what quantity of matter would be carried away (in addition to that held in mechanical suspension) by the transporting powers of bodies of water ponded back and suddenly set in action. The results may be stated as follows, viz. :—

1. A two-feet head of water . Deposit in sewer composed of soft mud and all descriptions of filth and a little silt.

The proportion of matter carried away by the united action of the weight, velocity, and volume of the water, was as 1 to 6½ of water. This was conveyed 2,400 feet to a main line of sewer, which has a body of water constantly passing through it with sufficient force to keep it always clean ;

the only signs left of the passage of the loaded water was a discolouration of the sides of the sewer to the height the water of the flush had reached.

2. A two-foot head of water. . Deposit in sewer composed of small pieces of brick, stones as large as walnuts, oyster-shells, decomposed animal and vegetable matter, and silt. Proportion of matter 1 in 16 of water.

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The Commissioners of Sewers for the Holborn and Finsbury division having satisfied themselves of the advantages of a systematic use of flushing in cleansing sewers, have for upwards of three years followed out the principle; the results are such as they anticipated. In carrying out the plan, the construction of new sewers with side entrances, and the inserting side entrances to old sewers; the forming gully-holes and shoots on a plan that may supersede cleansing, as formerly obtained, and the delivery of the water through them in such a manner as to assist the current of water in the sewer; and these and other minor improvements, by the use of which there is a saving effected, are carried on in one comprehensive system, connected with the systematic flushing of the sewers.

The great principle intended to be carried out is, that instead of occasional cleansing, as formerly, the sewers should, when once cleansed, be kept free from deposit. The pecuniary saving is, I consider, the least advantage of this mode of cleansing; the great points attained are the avoidance of all accumulations of filth in the sewers, and the stirring up in removal, and consequent disagreeable effluvia, is also avoided; the streets and pavements are undisturbed; the men engaged in cleansing sewers have a more healthy employment than heretofore; private individuals are saved from the annoyance of their drains being choked; and as this plan of flushing affects the health and cleanliness of the inhabitants, the accomplishment of it, on a general and systematic principle, should be deemed of the utmost importance.

The deposits made were those which were left, besides those carried off?—Yes. I afterwards tried the plan of flushing, to see what could be carried away, showing the increase of the animal and vegetable matter held in suspension in the water, from the upper part of the Fleet down to the lower part of Saffron-hill. I made the experiments over a distance of nearly two miles.

Is the system of flushing universally adopted in the district? —The Commissioners have adopted the principle, but they intend carrying it out thus: to wait until parties complain of the sewer requiring cleansing, as we used to do. As soon as they complain, we wash the deposit out of the sewer by board dams; the flushing apparatus is then fixed, and we never allow the deposit to accumulate afterwards, so that the application of the apparatus is proceeding progressively. As we wash away the deposit in the sewer so much cheaper by board dams than by the old system, the Commissioners incur no additional expense in placing the apparatus. (Mr. Mills.) The expense of paving had been increasing to such an extent for some years past, the attention of the Commissioners was drawn to the question whether they could not avoid breaking up the pavement; and it was found on calculation that the cost of putting down one of these flushing apparatuses

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was less than cleansing the sewer in the old way, while the apparatus remained for future use at no more expense than the men's labour. (Mr. Roe.) In the sewers cleaned there were 6,688 cubic yards of foul deposit; the whole cost of getting out that would have been 2,387*l.* The men's time occupied in the washing that away with board-dams was 644*l.* 12*s.* 7*d.*; so that we had in fact a surplus left, which enabled us to put inside entrances and flushing gates, which cost 1,293*l.*; there was then a saving of 455*l.* to the Commission.

That does not include the expense of taking up the pavement? —No; all those side entrances should not be placed to the flushing account, they are of such immense benefit to the system of sewers; they should be adopted instead of man-holes to the old sewers, to enable us to inspect the sewers, and do what is needful, without breaking the pavements and the road; therefore they should not be charged upon the flushing system; but we have charged it to that account.

What is the advantage of a side entrance over a man-hole? —The man-hole is placed in the centre of the street, to obtain access to which we have to break the pavement.

Would it not be possible to have a covering over them which should be merely lifted? —It is possible; it is only a question what sort of covering it should be, to be safe for horses to pass over.

Can you give the comparative expense of keeping clear the district by the old system and by flushing? —There are about two-sevenths of the Holborn and Finsbury district now supplied with flushing apparatus; the annual cost of cleansing those by the old mode would be 326*l.* 17*s.*; the cost for men to work the gates now placed, that is, keeping the sewers clear from deposit, is 106*l.* per annum, leaving a saving of 220*l.* per annum on those two-sevenths.

What was the cost of the flushing apparatus? —The cost of the flushing apparatus for those sewers has been 434*l.*

The absolute cost of keeping the sewers clear by flushing is less than one-third of the former cost? —Yes, about one-third of what it used to be.

And also without any nuisance to the inhabitants; whereas it was formerly a great nuisance? —Yes.

What is the difference of expense in case the streets are Macadamized, or paved with stone or wood? —Wood pavement was not laid down in the district at the time I made my experiments, but it was Macadamized for the greatest portion of the sewers, and then there was the greatest deposit of gravel or silt.

Do you believe that with the wood pavement it will be less than with either of the other two? —I do.

Do you believe if the flushing system were carried out, there

would be little difficulty in carrying away the mud from the surface?—There would be no difficulty if the supply of water was sufficient.

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If the wooden pavement were adopted, do you think there would be any difficulty in carrying off the whole of the surface matter through the gully-holes?—No difficulty at all, if we had only a sufficient supply of water.

Are you aware that there has been an improvement in the depth of the Thames lately in consequence of the removal of Old London Bridge?—Yes.

Is the driftway greater than it was?—It is.

You do not apprehend any danger of your plan filling it up again?—No.

Whence do you get the water you make use of for flushing?—At present the common drain water in the sewers is sufficient for our purpose; in some sewers the water is considerable on the mornings the water-companies supply water to the inhabitants, for then we find a supply of water in every sewer.

Is there not a direct communication between the supply of water and the sewers?—There is this communication, that persons having water let on to their houses, in the middle or lower ranks, do not take that care of it which they should do; they let it run over for half an hour or an hour, and it runs into the sewers, and that water we take care to save by shutting one of the gates for the purpose of flushing. In some cases the Commissioners have caused two sewers to be connected together, one having a constant supply of water and the other but a limited supply, and by diverting the constant supply into the other, we have effected a flushing.

How often do you flush those sewers?—It is not necessary they should be flushed oftener than once in a quarter of a year. When the apparatus is applied to a district or line of sewer, one man can manage 15 miles of sewer; but we find he can do more, and therefore he flushes them oftener.

There would be no difficulty in economizing the water in the upper part of your district for flushing, if it was necessary?—No; it would be attended with expense, that is all.

If you had a good supply of water, might not the size of the sewers be decreased?—Yes; it would depend upon the supply of water.

You would provide for a regular system of flushing?—Yes.

Do you conceive that you send a large quantity of deposit down into the City?—Whatever goes into the sewers in the City, passes through; I do not think it stops there. I have tried the experiment, and instead of leaving any deposit in the City, we have actually removed deposit the whole length of their sewer.

You have only flushed a part of the drains yet?—About 16 miles of sewers.

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The whole communicate, more or less, with each other?—
Yes.

Then, when the rest is done, the whole will be much more clear of foul air than they are now?—Yes. (Mr. *Mills*.) A few years ago the gas in the street, or the gas in the houses, became so offensive that the Commissioners were exceedingly annoyed by the numerous applications to remove the cause; and I believe the clamour of some individuals became so great as to threaten the Commissioners with an application to the Court of Queen's Bench. It was felt to be so important, that the opinions of the Attorney and Solicitor-General were taken how far the Commissioners, as Commissioners of Sewers, were liable to remove or abate this evil. The opinions of the Attorney and Solicitor-General were, that this having taken place since the Commissioners had been created by Act of Parliament, it was not one of those evils they were bound to remove. However, the Commissioners thought it was desirable that the public should be relieved; and they considered the question, and came to a resolution that, if persons applying to get relieved from the effect of the gas would pay 1*l.* 10*s.*, they would put them down an air-trap, the openings for which, together with the ventilating grates, may be seen in the streets; and any person applying in consequence of sustaining any inconvenience by the gas escaping from the sewer, may, by the payment of that sum, have a trap put.

Have you had complaints from those districts in which the flushing system was introduced?—If the gas-pipes are deficient, and the gas escapes, it may become noxious; but we have had very few complaints since; it must be from accident if they do occur.

It will be now the exception, as it was formerly the rule?—
Yes.

It has been stated to the Commissioners, that the nuisance from drains was chiefly from the private-house drains, that they are badly constructed, besides being perforated by rats, and otherwise; do you believe that to be the case?—Very much so.

You do not believe that the nuisance arises in all cases from the main sewers?—Not always from the main sewers. (Mr. *Mills*.) Connected with this point, I would mention, that where the sewers came in contact with churchyards, the exudation is most offensive.

Have you noticed that in more than one case?—Yes.

In those cases have you had any opportunities of tracing in what manner the exudation from the churchyards passed to the sewer?—It must have been through the sides of the sewers.

Then if that be the case, the sewer itself must have given way?—No; I apprehend even if you use concrete, it is impossible but that the adjacent waters would find their way even through cement; it is the natural consequence. The wells of the houses adjacent to the sewers all get dry whenever the sewers are lowered.

You are perfectly satisfied that in the course of time exudations

very often do, to a certain extent, pass through the brickwork?——Yes, it is impossible to prevent it.

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Have you ever happened to notice whether there was putrid matter in all cases where the sewer passed through a burial-ground?——The last churchyard I passed by was in the parish of St. Pancras, when the sewer was constructing. I observed that the exudation from it into the sewer was peculiarly offensive, and was known to arise from the decomposition of the bodies.

At what distance was the sewer from the churchyard where you found that?——Thirty feet.

(To Mr. *Roe*.) What is the general fall in your sewers; what do you consider a fair fall?——I find in the regulation of the Commissioners a fall of a quarter of an inch in 10 feet is required as the least fall; but we give them as much fall as we can; there are places where we cannot get a quarter of an inch in 10 feet. The outlets of our sewers are not under our own control.

In that case do you find the flushing effectual in a horizontal line?——Yes.

You are obliged to put your flushing-gates nearer?——Yes; we have a sewer building on a dead level, in consequence of the difficulty of the outlet; in that case we have placed a gate for 1600 feet; and we are in hopes we shall do with a greater distance than that hereafter; but that is the greatest length we have had an opportunity of working on a horizontal direction.

Mr. ROE, C.E., further examined.

Mr. Roe, C.E.

HAVE you been called upon by the Head Master of Eton College to examine the drainage of Eton and propose measures for its sanatory improvement? And were you called upon by the Town Council of Derby to advise as to the best measures for the sanatory improvement of that town also?——Yes, I was consulted in both instances upon the state of the drainage, and as to the best method of relieving both places from the effect of occasional floods. I was instructed to make an examination of the whole of Eton. At Derby certain plans and papers relative to a portion of the town, called the Brookcourse Drainage, a brook which serves as the main drain of the town, were placed in my hands, and I was requested to make such inquiries as I might think best for forming a report on the best means of effecting the purposes above named.

Did either of these references include constructing drains for the drainage of the houses?——At Eton it did; not at Derby.

Did either of these references include the laying down supplies of water?——At Eton the reference included the consideration of a supply of water for flushing the sewers, but not the house-drains; the drains to the houses more immediately connected with the

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College were flushed occasionally. At Derby no reference was made to me to consider the question of supplies of water, only the consideration of the means of getting rid of the excess.

Did either reference include the consideration of the means of using the refuse for agricultural purposes?—In neither case was any such reference made to me. I, however, adverted to the subject in my report.

May it not be considered, without paying any undue compliment, that both the bodies from whom you received instructions, and with whom you communicated in these instances, were bodies possessing a high degree of general intelligence?—It may be confidently stated of both bodies. The officers with whom I communicated at Eton were men of business habits and talents, as well as possessing such acquirements as their official station may denote.

Would not instructions given or instructions taken by persons of a high degree of general information, but without the special knowledge of the progress made in the arts and sciences applicable to sanatory measures, commonly omit the most essential portions of the measures necessary for the sanatory improvement of a town population?—Yes, certainly, until the knowledge of these subjects becomes much more generally diffused than it now is. None of the papers or plans which, at Derby, I received, prepared by engineers and townspeople upon the same instructions which I had, alluded to the subject of the house-drainage or the profitable application of the sewage, and only one of them alluded to the subject of supplies of water as connected with it. In respect to Eton, I would mention that the College is provided with sewers constructed at the time of the foundations being formed, and the person who laid them out 400 years ago provided reservoirs and sluices for the purposes of flushing them with water; and those sewers have been kept free from deposit by periodical flushings ever since. I found also that the portion of Eton, more immediately in connexion with the College and under its influence, was in a very different state to that portion of Eton over which the College could exert less influence on sanatory points. In my instructions the heads of the College directed that I should render the town of Eton every advantage to be derived from their expenditure in obtaining a good supply of water from the river Thames for flushing the whole of the sewers that might hereafter be built in that town. Altogether I found that where the College had power, everything conducive to health that could be thought of by them had been done; and the few suggestions I considered requisite were immediately agreed to.

Have you been consulted from any other place than Eton and Derby?—Yes, from Shardlow, in the neighbourhood of Derby, and other smaller places.

Of the new and improved sewers which have been constructed

for the relief of old districts under the Commissioners of Sewers of the Holborn and Finsbury Division of Sewers in the Metropolis, where the present Act gives the Commissioners no power to form house-drains or subordinate drains, and where it is optional with the owners whether they shall make use of the main-drains, and form the smaller branch house-drains or not, what proportion of the houses have been drained into them?—Certainly not more than one-third.

What is the obstruction to the use of the sewers?—The immediate expense undoubtedly of making the drains.

If house-drains were formed upon a general contract, and of the best and cheapest material, glazed or tube tile, how far might this expense be reduced?—More than one-half, certainly; wherever an inch in 10 feet fall may be got (and with proper management it might be got for drains in almost every instance), tile tubes would amply serve for the drainage of houses. I know one instance of an iron pipe, *three* inches in diameter, put into a sewer 50 feet distance from the house about 11 years ago, and having a fall of about an inch in 10 feet, which has never been obstructed.

And on the principle proposed of the distribution of the charge for improvements as a rent over a period coincident with the benefit, nearly the whole inconvenience, and all injustice to owners of short interests of the immediately outlay might be got rid of?—That principle of the distribution of the charge is essential to all plans; it is only justice in sewage and drainage especially. The improvement is permanent, and it is manifestly unjust that the whole cost of it should fall upon the present owner.

Besides the economy, would not the comprehension of the formation of the branch-drains under the same system as the main-drains be necessary for any efficient or systematic drainage of a town district?—The great fault which now effects the sanitary condition of our district is the extensive absence of the house-drains, or their bad construction either as to form or material. The Commissioners of Sewers have no power to oblige parties to drain into a sewer after they have built it, and although some are willing to contribute towards the cost of a sewer and to communicate drains therewith, others are not.

Does not the construction of drains from houses into the sewers require peculiar care and skill?—The proper drainage of a house after a sewer has been built in front thereof requires particular attention as to level and material. There are few situations possessing a sewer where the drains could not be constructed with regard to level and form in such a manner as to scour themselves with the water that passes through them; but too often little regard is paid to level, beyond ascertaining the fact that the sewer is low enough to drain the house, and there being no com-

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petent authority to enforce generally a proper system of house-drainage, the result is that a periodical expense is frequently entailed upon the subsequent owners or occupiers in the article of drain cleansing, which by a judicious management in the first instance might have been avoided. An example occurred the other day in our district. The line of a proposed new street was laid out, and the construction of a new sewer for about a thousand feet in length commenced by the individual who had leased the land for building. The depth of the sewer offered ample means for good house drainage. As a matter of economy the drains were put in for each intended house as the sewer proceeded, and were continued to the line of the fronts, leaving the part under the houses to be constructed, when the digging for the foundations takes place. The sewer building, although done by a private individual at his own cost, was subject to the regulations of the Commissioners of Sewers, whose surveyor and clerk of the works superintended the construction and level thereof, as they do all sewers so built, as well as those built by public contract. The digging out the earth for the drains was let by the builder to one man, and the putting in the brickwork to another. The ground digger, to save a little labour, gave the drain a sudden rise from the side of the sewer for a short distance, and then carried his work nearly on a level for the remaining length, thus destroying all the advantage to the house draining of a deep sewer for the sake of saving himself the removal of earth, the labour of which might be worth on an average half-a-crown for each drain. I observed the manner in which these drains were being put in, and inquired if there was no one connected with the land or buildings who paid attention to the matter, and finding that the men were left to themselves, I told them that unless the drains were put in at a proper level they should not be allowed to connect with the sewer at all, and that they must alter the three which were partly done; one of them I found had a fall towards the house instead of towards the sewer; the others were nearly on a level. This remonstrance produced the desired result, and the whole are now proceeding in a proper manner, the clerk of the works taking care that my directions are properly carried out. But it should be remembered that I had really no authority to oblige the parties to build the drains in a proper manner; and in numerous cases neither surveyor nor clerk of the works see how the drains are built, it being a matter over which we have no right of control. It is only *indirectly* that we have any control over the building of the sewers. If the parties do not accede to our regulations, they may be refused permission to join our main lines.

Was that sewer constructed, as to its level, merely for those building, or with a view to being further extended and rendered available for increased drainage?—That sewer was kept at a

greater depth than was necessary for the drainage of those particular houses, for the purpose of extending the sewerage to a portion of land on the other side of the hill.

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Is it consistent with your experience that a district where the houses have badly constructed drains with insufficient supplies of water are nearly in as bad a condition as a district having only cesspools?—Drains of this description are, in fact, a series of widely spread cesspools giving off emanations, and often requiring cleansing.

Sewers alone, without connexion with the branch drains, can only carry off surface water?—That is of course.

Therefore you concur in the general conclusion that for the efficient and economical improvement of any district, the three measures—first, of proper supplies of water carried into the house; secondly, properly constructed drains to carry out of the house all surplus water, and all matters held in suspension; and thirdly, main drains or sewers acting on the same principle for the conveyance of refuse in suspension ought to be combined?—Certainly the three measures are necessary, and in an entirely new district there could be no difficulty in combining them; in districts where the sewers are under the public control the drains ought to be so too, and where incorporated companies have constructed works for supplies of water with private capital, their interests might be secured, and even promoted by proper arrangements for the purpose, and there can be no doubt of their readiness to furnish an adequate supply.

It appears from your evidence that the expense of the first class main drains has been reduced from 21s. to 15s. for the sewers of improved construction, have you not reduced the price of the second class sewers which are used in the side streets?—Yes, from 15s. to 10s. and in some cases to 8s. 6d.

Have you effected the reduction in the cost by reducing the size of the sewer, or by lessening the quantity of material used, and introducing other systems of economy?—Generally by lessening the quantity of material used, but in some peculiar cases by reducing the size of the sewer.

What is the size required by your Court for house-drains, and what do you charge for the portion executed by you, together with the flap?—The Court of Sewers for Holborn and Finsbury Division do not require any particular size for house-drains; they would prefer the smallest size that can with propriety be used; their regulations are, that no drain shall exceed nine inches in diameter, and they allow parties to make them as much smaller as they please. The portion of private drain formed by the Commissioners' workmen under the existing contracts is not at present provided with a flap, but that contract expires in June next; and, under a fresh contract, it is proposed to have two prices—one for the drain-mouth without the flap, and the other including an air-

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tight flap. These are intended to be formed in cast-iron, and will diminish the cost to the public 4s. for each mouth without a flap; and, including the flap, the cost will be 2s. less for each drain-mouth than is now paid for the three feet of drain having no flap.

What is the charge made by you for gully-flaps, and on what terms do you put them in, and what materials?—The charge at present to parties requesting to have a gully-hole trapped is 30s.; but this will be reduced to about 10s. in the next contract. Some of the flaps are formed of cast-iron, and others of slate.

Do you conceive that it will be practicable to reduce the whole charge of the complete apparatus for draining, cleansing, and supplying water to districts below the existing charge for the proper cleansing of cesspools, and defective house-drains and sewers, in which accumulations are allowed to take place, which are removed by hand-labour and cartage?—Yes; if the supplies of water can be properly carried into the houses, I have no doubt of a general reduction in the total amount of the existing charges. By the adoption of the principle of cleansing, and keeping the sewers clear by flushing or removing immediately all matters in suspension in water, a saving in that branch alone accrues of full 50 per cent. The saving in our district, during the last year, was sufficient to pay for all the flushing gates and side entrances placed on the old sewers, and to be used for years to come. The expense of cleansing cesspools may be fairly put down at an expense of 17. per annum for each cesspool: this is an expense which falls on individuals, and therefore does not form part of the above estimated saving of 50%. per cent.

In an extract from a report made by you to the Court of Sewers for the Holborn and Finsbury District, transmitted to this Commission in January last, it is stated that a saving of 7,900*l.* has been effected, in the year 1843 alone, by the improvements adopted in those divisions. Will you state the mode in which the calculation is made, and the gross amount expended in the building of sewers in that year, both public and private, by which the saving has been effected?—The following is an extract from that part of the report giving a detail of the saving in each particular work, which I believe was not sent to this Board:—

“During the past year 39 side entrances and 41 flushing gates have been placed in about $10\frac{3}{4}$ miles of old sewers, from which the foul deposit had been washed away; these gates, together with those put in before, are in constant use for flushing out $26\frac{3}{4}$ miles of the old sewers; these, with $19\frac{3}{4}$ miles of new sewers built on the improved principle, form a total of $46\frac{1}{2}$ miles of sewer in these divisions, which are now periodically washed out.

“The gates and side entrances to the old sewers have also this year been put in without any extra charge, as after deducting from the cost of removing the deposit by the old method, the expense of the side entrances and flushing gates, and of washing away the deposit, and keeping the sewers clear to this time, the difference in favour of the Commission is

above 300*l.*, with the advantage of the apparatus being fixed to keep them clean in future. Mr. Roe, C.E.

“The facilities afforded by the side entrances for cleansing old gully-shoots into the sewers during the last year has been the means of saving above 200*l.* in the article of paving round the gully-holes; and the paving saved by washing away the deposit from the sewers instead of breaking up, as before, the pavement and roads would have cost above 250*l.* to reinstate.

“Had the sewers which have been washed out during the last year been cleansed in the old manner by opening the streets in various places, bringing up the foul and obnoxious deposit to the surface, allowing the same to remain in the streets until carted away, and also the whole of the gully-holes, there would have been upwards of 1600 openings required in the streets, all of which have been rendered unnecessary by the improved method of cleansing, and the obstructions and nuisance consequent thereon avoided.

“There have been 542 gully-holes, and 12,292 feet of gully and shoot formed during the year 1843 upon the improved plan; the saving in the expense upon this is above 1800*l.*

“The saving in the 542 new gully-grates, by using the improved plan, has been above 350*l.*

“The expenditure of above 150*l.* has been avoided by the present method adopted for cleansing old gully-holes and shoots.

“The improvement in the form and construction of new sewers has, in the past year, produced a saving of 2289*l.* in a length of 13,508 feet of sewer.

“In the 22,590 feet of new sewer built by contract in 1843, the introduction of side entrances in lieu of man-holes for cleansing has effected a saving of 1711*l.*, exclusive of the advantage of having flushing gates fixed where deemed necessary for washing out the sewer.

“On 18,248 feet of new sewers built by individuals upon petition, a saving of 1027*l.* has been effected by introducing side entrances in lieu of man-holes for cleansing; this is also exclusive of the flushing gates fixed thereto.

The gross sum expended in building public sewers has been furnished to the Board by the clerks to the Commissioners of Sewers, and amounts to about 20,000*l.* The amount expended during the past year in the building of sewers by private individuals may be stated at about 12,000*l.*, the length being 18,248 feet. These sewers were built according to the regulations of the Commissioners of Sewers, and under the superintendence of their officers.

In your report to the Court, made in the month of January, 1843, you stated that—

“The sewers of the Holborn and Finsbury divisions have of necessity been adapted to such outlets as the other districts respectively afforded; and these having formerly been put in without a due regard to an extended drainage, the sewers of your Commission have not had the benefit of the best fall that could have been obtained. Of late years, many of the outlets have been lowered in the adjoining districts; but to alter the existing sewers of these divisions would require the rebuilding of 323,766 feet of sewer, at an expense of about 200,000*l.*, exclusive of the cost of connecting the sewers where the cutting would be deep, and the existing surface and house drainage, which would make the total amount of cost nearly a quarter of a million.”

Mr. Roe, C.E. What proportion of this expense might have been avoided if a proper survey had been made, and the works executed under one management?—Had a survey been made some centuries back with reference to the proper drainage of the district in and around London, and the now existing sewers built according to the levels so ascertained, none of the expense here stated as requisite to lower existing sewers to the right level would have been needed; nor would the direct cost of putting in the existing sewers to the proper level have much exceeded the actual cost, the difference being only in the extra depth of digging; whilst that difference has been more than counterbalanced by the expense of cleansing, created by the want of proper levels being universally used from the lowest outlets.

At Eton, were the measures proposed complete by arrangements for the cleansing of the houses by supplies of water laid on in the houses, the removal of all cesspools, and the prevention of the permeation of the substratum by decomposing refuse and its conveyance in closed drains to properly trapped sewers?—Yes, the arrangements proposed were complete, for the premises belonging to the College, and those immediately in connexion therewith; but the town itself was not subject to the same authority, and has not at present decided on having the benefit of house draining and cleansing.

What is the boundary of that district which you describe as connected with the College?—As distinguished from the town, I should describe it as the part generally known as "College," or within "bounds," extending from Barnes Pool Bridge on the south to Spier's-corner on the north, and on the west bounded by a line drawn from the extremities of Keate's-lane and Angelo's-lane, including, of course, all the collegiate buildings down to the river.

In what condition did you find that part of Eton with respect to drainage and sewerage?—The college has a good sewer provided, as I before stated, with flushing apparatus regularly used. The collegiate buildings on the south drain to a covered sewer passing from Barnes Pool Bridge towards the river. Many of the houses on the west side have drains into a small covered sewer which empties into the Timberhalls Meadow; a few houses have connexion only with cesspools, well secured from effluvia by traps and water-closets. The cesspools are cleared out during vacations. Altogether, in this portion, great care has been taken to keep everything as clean and salubrious as possible; and works are in progress to supersede the cesspools, and to form a complete and efficient sewerage and house drainage, with an ample supply of water for flushing the whole.

What is the general state of the drainage in and around the town?—The drainage of nearly the whole of this part is in the most imperfect state. Some of the houses drain into cesspools,

others into drains which empty into open ditches, along which there is no run of water, except during floods, which occur perhaps once a-year. The open ditches on the west side have their outlets by covered sewers across the main street to the east side thereof into another open ditch. Into this latter ditch a considerable portion of the property on the east side of the main street also drains. This open ditch, when I saw it, had no perceivable outlet. The sewage of this portion of the town therefore stands in open ditches; and, unless when a flood arises and pours its waters into them from the west, the filth from privies, pigsties, and slaughter-houses stagnates, and the foul water is left to soak away through the gravelly soil or evaporate in the air.

Did you find that advantage has generally been taken of the facility of obtaining water from the river to carry off all impurities as rapidly as they are created?—In the College part, as I have stated, but not in the town.

You state that Eton is liable to periodical floods; did you find that the inhabitants relied on the effect of these floods to free them of the filth that collects between the periods of their recurrence?—In the town it would appear so, from the general state of the drainage and the neglect of the outlets.

Although such a periodical flushing may have the effect of cleansing the ditches and some of the drains, and so far diluting the soil in the privies that the nuisance of the stench arising from them may be lessened, will it not have the effect, when the foundations and cellars of the houses are flooded, as is the case at Eton, of impregnating the whole of the subsoil with that filth, and will it not remain after the water has subsided, constantly poisoning the atmosphere?—From the state of the town drainage already described, those evils undoubtedly take place there; but the college, kept clean and standing on higher ground than the town, does not suffer with it by the floods; and the hollow from Barnes Pool Bridge to the river, along which and by the sewer in that line there is a continual flow of water, prevents the subsoil from being impregnated by the filth of the town.

If the public possessed a proper degree of intelligence on these subjects, would you expect to find such a system advocated in preference to a regular flushing of the main sewers by supplies of water from the river, and the introduction of house-drains with an adequate supply of water?—Certainly not.

From whence do the houses get their supply of water in Eton?—Some from wells, and others from the river by the waterworks, which are situated near the Weir.

Are the houses in College generally supplied with water from the waterworks; and are they also furnished with water-closets?

—Yes, generally so supplied with water; and all, I believe, have water-closets.

What measures recommended by you are now in progress for

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improving the drainage, as far as the College is concerned?—— Contracts are about to be entered into for lines of new sewer (where none exist) in every portion of that part north of Barnes Pool Bridge; also for drains to every house to connect with the water-closets, having proper traps, and including works for an ample supply of water to flush the same regularly.

Did you in your plans for the improvement of the several places where you were consulted for measures of sanitary improvement so direct them as to facilitate the application of the sewage water, or other refuse to agricultural production, by irrigation or otherwise?——Yes; but at Eton I did not recommend its use in the immediate neighbourhood, because the meadows in the vicinity of the college are used as play-grounds by the scholars, or for recreation by the inhabitants. I stated my opinion of the great value of the sewer water for irrigation, and recommended that the sewers should be so constructed that the contents might at another opportunity be carried to a distance, where the same reasons against its use would not obtain. At Derby, I strongly recommended that it should be applied. My opinion is, that if the sewer water were properly applied there, it would pay the expenses of the sanitary improvement of the town. I stated in my report that—

“Whenever the Commissioners may determine to commence operations for the profitable application of the sewer refuse, the common run of water in the brook might be conveyed to near the outlet at small expense, and in such manner as to derive its full power to be used in raising the foul sewerage to a level, whence it could be conveyed in pipes to the different meadows for irrigation; and when not required for this work, it would pass to the mill-tail by the main line. As some power would be required to raise the foul sewerage for irrigation, and Mr. Frost, who is a very competent judge, considers Messrs. Evans’ right to the Brookwater as worth about 500*l.*, this would be the cheapest mode of obtaining lifting power; and Anthony Radford Strutt, Esq., in his letter to Mr. Frost, strongly recommends the purchase of this water-right. The flood-waters can be passed off without such purchase taking place; but on the grounds of public health and utility, I would call the attention of the Commissioners to the subject. The profitable application of the filth from the sewers is a point which has not received the general consideration due to it; for, until Mr. Chadwick, in his ‘Report to the Poor Law Commissioners, on the Sanitary Condition of the Population of Great Britain,’ drew public attention to the subject, little had been said or thought of it. In the case of Edinburgh, the increase of the value of poor lands thus irrigated is shown to have been from 30*s.* to 15*l.*, and in some cases to 20*l.* per acre; other lands once let for 40*s.* to 50*s.* per acre now let for very high sums. It is true that the inhabitants around those meadows object to it as offensive; the value, however, of the irrigation is seen by the parties interested in about 300 acres of land, estimating the compensation that would induce them to discontinue the practice at the sum of 150,000*l.* In the case of Derby, the refuse may be conveyed by pipes to the meadows below the town, where no such objection could arise; and the residue not used in irrigation would pass, without raising, into tanks situate at a distance on the banks of the canal, which offers a ready and cheap means for conveying the solid portions to distant places for manure. Captain Vetch, an experienced engineer, states in his Report on the Drainage of Leeds, ‘that from the researches in agricultural che-

mistry, and from the usages of other countries, the value of the manure for each person in a town, may be safely estimated at 10s. per annum.' The population of Derby is about 35,000; of this population, about two-thirds could drain to the proposed sewers; the value of the manure to be conveyed to the sewers, if proper water-closets were adopted, would, therefore, be about 11,000*l.* per annum. It is not, however, to be expected, that the manure would be immediately applied, so as to produce its full value; still, if it be admitted that in a few years it would reach one-fifth of its value, or 2200*l.* a-year (and this it might by irrigation alone), it would be bad policy to allow so much fertilizing matter to be sent to the river, where it is lost to every good purpose as regards the town of Derby. At those periods when irrigation was suspended, the foul water would pass into tanks formed to receive it, where the more solid portions would precipitate, and afterwards be taken out and boated away for use as manure. Mr. Smith, of Deanston, and other authorities on drainage and irrigation, consider the application of sewer refuse by irrigation as the most productive mode of distributing the manure. The contractor for the soil from privies and cesspools in Paris pays to the Municipality the sum of 22,000*l.* for the right to use it for the present year. The cost of mill-house and machinery to raise the sewer-water for irrigation, with iron pipes to convey it half a mile below the town, with a sewer and tanks for receiving it when not used in irrigation, with compensation for land, &c., would not exceed 4500*l.*, including the sewer to convey the brook-water to the wheel, if the right to it is purchased from Messrs. Evans. Forming the meadows for irrigation would cost about 5*l.* or 6*l.* per acre. The annual cost of attendance to the sewer-water would be trifling."

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From your present experience of the area of local jurisdictions and powers, and of measures commenced by local authorities, and carried on by them, do you conceive that, with any powers, however adequate, which the legislature might give, that economical and efficient combined sanatory measures could be expected to be carried out without aid or guidance from a disinterested and otherwise competent authority?—The town of Derby affords an example that they could not. In that town, although as an intelligent and highly respectable inhabitant states to me, all agree in the great want of drainage, yet the only work at present decided upon is a part of what I recommended, and which part, when carried out by itself, will, perhaps, do as much harm as good, (as I have stated in my report to them), tending to lessen the height of the flood-water in one part of the town, and to raise the height thereof in another part; the additional outlet required and suggested not being noticed in the works at present proposed to be done. The only objection I heard to the whole plan was the amount of immediate expenditure. An influential member of the local commission states in a letter to me, "Every one admits the efficiency of your plan, even the opposers of its adoption." The letters from the town to me state, that divided as the existing authorities are in parties who distrust and obstruct each other, it is impossible for them in their present condition to carry out any large measure, although so greatly needed, some of the most intelligent inhabitants have urged the necessity of a distinct local body, specially constituted for the care of the drainage and sewage,

Mr. Roe, C.E. and for sanatory improvements “independently,” as one letter states to me, “of all other objects.” In this view I entirely agree. The application of the sewage of that town to agriculture would require an extension of jurisdiction beyond their present boundaries. I am fully convinced that no efficient relief can be given to any districts of the towns, especially the poorer districts, without the exercise of a powerful discretionary authority, competent to give instructions, as well as to compel the adoption of proper measures.

Since you were last examined, have you made any further experiments in flushing with a view to carrying off the contents of your sewers through the adjoining districts, on which you are dependent for an outlet?—Since that time I have had an opportunity of trying experiments on a more extended scale than before. The particulars and results are embodied in the accompanying report lately made to the Commissioners of the Holborn and Finsbury Divisions:—

“The surveyor respectfully begs to lay before the Commissioners the result of the inquiry ‘as to whether the flushing of the Finsbury sewers through the Tower Hamlets sewers would cause a deposit from the former to lodge in the latter.’

“The inquiry arose in the following manner, viz.:—Your Commission some years back constructed a new sewer in Goldsmith’s-row, Shoreditch. Prior to letting the contract you directed me to apply to Mr. Beek, the surveyor of the Tower Hamlets, to learn at what depth a proposed outlet sewer by that Commission would be brought up Warner-place to the junction of the two Commissions; the reply stated a depth of 14 feet 6 inches; and your sewer in Goldsmith’s-row was put in accordingly. As, however, the then existing outlet (an open sewer) was several feet above the level of the sewer put in Goldsmith’s-row, and as the outlet in Warner-place was not built for several years, an accumulation of foul deposit obtained in Goldsmith’s-row sewer, which it was considered necessary to remove when the new outlet was brought up; an order was therefore given that men should flush the same away. Before the flushing began, the Commissioners of the Tower Hamlets wrote to your Board, requesting to be informed when the flushing would take place, and Mr. Unwin, their clerk, told me that the request was made with a view ‘to ascertain what deposit from your sewers might be washed into and lodge in the Tower Hamlets sewer.’ Openings were made to ascertain the depth of the existing deposits in both lines of sewer, and three men were then set to flush out the Goldsmith’s-row sewer with wood dams, &c., which they accomplished in three and a half days; the quantity of deposit in which sewer measured 55 cube yards, and at the former cost of such work would amount to 18*l.* 15*s.* 10*d.* When the sewer had been washed out, and a number of flushes of water sent through the Tower Hamlets sewer to insure the passage of the deposit, I wrote to Mr. Beek to inform him, and to say that on the Tuesday following it was intended to try what effect a flush of water from the Finsbury sewer would have upon the Tower Hamlets sewer on the east side of the Regent’s Canal culvert at Rhodeswell Common, a distance of two miles and three furlongs from the Finsbury flushing gate. The means used, and the results were as follows, viz.: several square boxes (which we have before used in experiments of this nature), each holding one cube foot of water, were taken on this occasion. Some of these were filled from the common run of water at both ends before the flush was let off, others were filled with the water after the flush had reached the lower end. After allowing the turbid water to

clear itself by precipitation, I ascertained the relative amount of the precipitate; the following are the results and particulars:—

- “ Distance of sewer at Rhodeswell Common from the Finsbury flushing gate in the Hackney-road, 2 miles and 3 furlongs.
- “ Height of flushing gate, 4 feet.
- “ Quantity of water headed up for one flush, 26,605 cube feet.
- “ Time required for head to rise varies from 6 to 24 hours.
- “ Proportion of decomposed animal and vegetable matter, and detritus from streets and roads held in mechanical suspension:—
- “ 1st. In the water used for the flush 1 in 810
- “ 2nd. In the common run of water at Rhodeswell Common before the flush was let off 1 in 540
- “ 3rd. The proportion of matter in the water when the flush was at the highest at Rhodeswell Common carried away by the united action of the weight, velocity, and volume of the flush-water added to the common run of water 1 in 80.
- “ The sectional area occupied by the common run of water at Rhodeswell Common was 3 ft. 1½ inches.
- “ The sectional area occupied by the united waters of the flush and common run at the same point; was 5 ft. 1 inch.
- “ The velocity of the current of the common run of water at Rhodeswell Common before the flush 95½ ft. in 1 min.
- “ The velocity of the current when the flush was passing Rhodeswell Common 114 ft. in 1 min.
- “ The effect of the flush began to be felt at Rhodeswell Common in 1 hour after the head was let off in the Hackney-road, showing a velocity of 209 feet in 1 minute in the covered sewer. For 42 minutes the height of water from the flush gradually increased until it reached the highest point, and it continued at that point for 13 minutes, when it gradually decreased, and in 3 hours' time from the effect being first felt the flush ceased to operate at Rhodeswell Common.
- “ After deducting the amount of matter held in mechanical suspension by the flush of water before let off, and that in the common run of water at Rhodeswell Common before the flush reached it, there remains the quantity of 21 cube yards of matter passed from the Tower Hamlets sewers by the use of this one flush.
- “ One of your honourable Board then suggested that experiments should be made with bricks to see what distance the flush-water would affect them. This was accordingly done, first with brickbats and then with bricks. After the first flush had passed, the bat nearest the gate was found to have gone 261 feet, and the furthest 529 feet. By the second flush the foremost had reached 1170 feet from the gate, and the hindermost, with one exception, 670 feet. After the third flush the whole were found to have passed a distance of 1300 feet from the gate. With the whole bricks we had time only for two flushes. After the first flush the nearest brick was 248 feet from the gate, and the furthest was 760 feet distance. The second flush moved the whole of the bricks, the foremost 160 feet further, and the hindermost 40 feet.
- “ The time was now come when the holes were to be opened for taking the depths of the deposit again; the result of which shows that flushing from the Finsbury sewers through the Tower Hamlets sewers does not increase the amount of deposit in the latter, but the contrary; and the result of the particulars taken at Rhodeswell Common evidence the fact, that the extraordinary head of flush-water of the Finsbury sewer in Hackney-road is beneficially felt through the whole of the 2 miles and 3 furlongs of the Tower Hamlets sewer, and doubtless thence to the river Thames.”

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I should state that I propose to continue these experiments, if I can obtain the concurrence of the Commissioners for the Tower Hamlets, to whose surveyor, Mr. Beek, an application has been made for that purpose.

T. L. Donaldson,
Esq.

THOMAS LEVERTON DONALDSON, Esq., examined.

You are chairman of the Westminster Commission of Sewers? —I am.

How long have you held that office?—About eight years. I have been a Commissioner twenty-seven years.

Over what district does your commission extend?—It extends from Temple Bar to Fulham, and from the river Thames to Hampstead, including part of Hampstead.

Have the goodness to state what parishes it includes?—Marylebone, Paddington, Kensington, Chelsea, and a small part of Fulham, part of St. Pancras, Bloomsbury, and St. Giles's, and all the parishes of the city of Westminster, including St. George's Hanover-square, and St. James's; in all 20 parishes, containing 60,000 assessable premises. It was first limited to the city of Westminster, and then part of the county of Middlesex was added to it. They are called the Commissions of Sewers for Westminster and part of the County of Middlesex.

Has the extent of the jurisdiction of the Commission been the same ever since you have been connected with it?—It has.

Does it include the parish of Hampton?—No; the general Commission goes up to Teddington, but the active jurisdiction of the Commission is confined as I have stated. We have never extended the jurisdiction to Hampton. A series of plans has, however, been laid down of the whole of the north bank of the Thames, from the Temple to Hampton, which shows the Trinity datum, and the highest and lowest tide-level, and many minute particulars, up to the Fulham town-meadows.

Why do you limit your operations to Fulham?—There is a special Act as to part of Fulham, enabling us to levy rates for works on sewers communicating with the Thames beyond the two miles' limit.

What is the date of the Act of Parliament limiting the extent of your jurisdiction?—Under the Act of Henry VIII., the Crown issues a Commission, including a larger sphere of duty; but we have confined it to the limits I have just mentioned. The Commissioners used to rate much farther; but in 1769, an action was brought to try their right, and a point of law being reserved, the judges unanimously decided, in 1770, that their jurisdiction did not extend beyond two miles from the City of London over sewers in which there is neither flow of tide nor passage of boats. The Court decided to apply to Parliament for additional powers

and jurisdiction, and appointed a special committee for the purpose of drawing a bill; but great opposition having been raised, the committee was dissolved.

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What number of Commissioners generally attend the meetings? —About 30 from first to last. They come in; some stay an hour or two, and some stay during the whole proceedings.

How often do the Commissioners hold their meetings? —The appointed meetings of the Court are twice in the month. There are besides four views by the Commissioners, and other occasional meetings by adjournment, to get through any arrears of business.

Do the same persons generally come? —The same Commissioners generally attend; and occasionally some come in who have not attended for some time.

Are all questions relative to the construction of the sewers decided at those meetings? —Yes; by the Commissioners present. They have the report of our surveyors on any point, and then they discuss that report.

The Commission is nominated by the Crown? —Yes.

How are the vacancies filled up? —By the Lord Chancellor putting in the names.

Gentlemen are recommended probably? —The last time the Commission was renewed, on the accession of the Queen, the Lord Chancellor himself filled up the vacancies.

What is the usual course? —Formerly the number who died off were allowed to be named by the Commissioners, and they submitted the names to the Lord Chancellor; he then added such other names as he thought fit; or, if he chose, he struck out some of the names.

The general course was to add those whom the Commissioners had recommended? —Yes; but that has not been the case for many years.

How long is it since that has been altered? —I dare say a dozen or fifteen years.

You have had 27 years' experience of the district? —Yes.

On what scale is the collective plan? —The engraved plan is eight inches to the mile, and the larger district plans 20 to 25 inches to the mile.

Are your levels marked upon those plans referable to any datum level? —We take the Trinity datum, as high as the tide flows.

Have you any plans, with levels, referable to that to show the depth of the sewers? —Yes; we have a book, and several volumes of plans, showing the depth of the sewers in different streets.

It is not on the plan itself? —It is on the sections. We have a vast number of plans and sections, showing the depth at which the sewers have been worked.

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Always referable to the datum?—No, not always, for the Trinity mark loses itself in the rising ground.

Is it referable to the Trinity datum on the ground rising above it?—As far as it is applicable it is on the Trinity datum.

Should you think a system of contour lines desirable on a map, so as to give you a view of your whole district as to levels, contour lines being lines of equal altitude?—We have not got those.

Would you consider that such lines would be useful in giving a general view of the whole district?—They might be useful.

What are the falls of your line of sewers?—The main sewers vary.

What would you consider a good fall?—I think 5 inches in 100 feet would be a good fall.

In what manner do you bring your sewers into contact with the main sewers?—Either by cants or by circles.

Is there any general system followed in carrying your sewers through a district?—Yes.

Are they all referable to some previously digested plan, or merely as the occasion may arise?—A great deal of our sewerage is old, and therefore we are obliged to provide for the exigencies of any particular part according to the existing sewerage, which we have endeavoured within the last 40 or 50 years to improve by deepening and altering the lines.

Is that always with reference to any arranged plan for the whole district?—To the existing capabilities it is always.

Those capabilities have been made effective, and the plans laid down with reference to them?—Yes.

Those plans are carried out?—Yes; but circumstances from time to time arise materially to influence the capabilities of the district; for instance, the removal of London Bridge has had the most beneficial influence upon the drainage of the Westminster Commission; the greater depth to which the tide falls is a very important circumstance, and has enabled us to lower the sewers in many parts, which previously we could not effect.

What are the sections of the sewers which you have adopted?—Upright sides, a semicircular arch, and a curved invert.

What thickness of walls do you employ?—14 inches the upright walls, and 9 inches the rest.

What mode do you adopt for cleaning your sewers?—Where the matter has become stagnant, it is raised to the surface of the ground, and carried away by carts; but that arises for the most part in the old sewers of imperfect construction, where they are decayed, or the bottom has formed a sort of hog's back. Where the bottom is of a circular form, the same opening and cleansing is not required.

Can you state the extent of sewers now cleansed by hand?—I cannot at the present moment.

What does the cleansing cost per annum?—About 1000*l*. T. L. Donaldson, Esq.
a-year.

Do you find that the flat-bottomed drains require cleansing the most?—Yes; and those which have an imperfect fall.

What is the amount of your fall?—Sometimes an inch or two in 100 feet, and sometimes less; then it is apt to clog up in the bottom.

Do you apprehend that a flat-bottomed drain is more likely to clog up, than one which is circular?—A flat-bottomed sewer is almost certain to clog up. We have not built any for 50 years.

Do you not apprehend that a simicircular invert is much better than a flat-bottomed drain?—Decidedly.

Do you think a semicircular is better than a curved invert?—No; I think not. The object is to drive the filthy matter from the bottom, and you do that just as much by a segment as a semicircle, at least almost to the same extent. There is this practical inconvenience in a semicircle, that in the examination of the sewers the men working in them are impeded in their operations.

In your opinion your curve, the segmental curve, is as effectual as a semicircle?—All things considered, I think for practical purposes it is much the best. We find that the ordinary current of water in the sewers does not rise above the inverts. There is no solid soil of human excrement, or vegetable, or animal matter, for when it gets to the water it is converted immediately in a fluid state, and if not allowed to stagnate,—it passes down with the current.

So that the refuse or silt can never rise above the invert?—It seldom rises above the invert, there is such a body of water, when the water is on for the supply of the houses, that the impetuosity of the current is very great.

That does not apply to the sweepings in the streets?—No; those are very heavy and very difficult to get away. But the Macadamized streets are not generally adopted in London, and we find in most instances that the showers will cleanse our sewers to a great extent, and carry the whole down to the river.

You consider that a great body of water driven suddenly through your sewers would clear them out?—Yes.

That being the principle of what is called flushing, do you not conceive that would be necessarily productive of good effects?—My opinion is, that the sewers ought to be so constructed as to require no artificial relief of that sort.

Wherein does the effect of flushing by a storm differ from artificial means?—By storms, the whole length of not only the main or conduit sewers, but also the minor sewers and drains, is cleared from all obstructions, and that enables all deposits to pass rapidly off.

You introduce a great volume of water, and discharge it suddenly?

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—A great body of water often fills three-fourths of the sewer, and goes right down to the river; but in the flushing system I apprehend you only carry down the contents of the sewers with the water a certain distance, and that effort must be renewed from time to time at various points, and you have again and again to overcome the *vis inertiae* of heavy matter.

Is not the principle the same; a volume of water introduced, discharged suddenly, and made to act upon the sewer; the same in the case of a storm as in the case of any artificial means?—No; for the operation of the storm is the same from the beginning to the end, generally spreading over a large extent of surface; whereas flushing is only partial, and at stated intervals, merely shifting from place to place, without carrying the soil from the sewers into the river by one operation.

Would not it depend on the volume of water introduced at a time. If the volume of water was large, would it not produce the same effect as the same quantity introduced in any other way?—I think that stopping the efflux of the water for a time is a great obstruction to it.

Admitting the flushing system to extend according to the volume introduced, is not the principle the same?—The principle is the same, except that an obstruction arises at intervals.

If by any means, without reference to any particular apparatus, large quantities of water could be introduced, would not they remove obstructions arising from the matter in the drain?—Doubtless they would, for we find that the showers cleanse our sewers to that extent; but I would not have any flushing apparatus—I consider it unnecessary.

Would it not be to a greater degree than by the slow percolation of water?—It might have a greater effect.

How would you make the sewer most efficient by your system? By making a curved invert and a sufficient fall.

What do you consider a sufficient fall for a sewer to deliver itself?—I think 5 inches in 100 feet will relieve the main lines.

In many instances you might not be able to get that fall?—I think if our levels are well formed we may always get that.

Do you in the main or the collateral sewers?—Not in the collateral sewers; our main lines we carry up at the greatest depths; we may be 20 feet below the surface of the ground. In the collateral sewers the same depth may not be required for the drainage of the houses, and we may therefore allow a much more rapid fall in those parts where it is generally the most requisite.

Would it not be as a general principle desirable to introduce a volume of water where the falls are inconsiderable?—Certainly, if there is not enough fall to carry off the matter, it is desirable.

If that volume of water is introduced suddenly, is not more accomplished than could be done by a continuous current?—Not the same as by a large continuous body.

A storm of rain does not supply a continuous body?—A T. L. Donaldson, Esq.
storm of rain extends over the whole surface where it falls, and is continuous from being carried through every description of channel, pipes, gullies, drains, and sewers, from its very commencement down to the river.

The question refers to an apparatus or contrivance to carry out that principle?—I am not speaking of the apparatus. I apprehend, with a flushing apparatus of the best construction, its operation will only go to a certain extent, about 1000 feet.

The question assumes, that you want to remove something in the sewer which cannot be accomplished by any other means except that of taking it out by hand?—I cannot speak as to any other mode of doing that.

Would you not consider that some arrangement, by which a volume of water could be introduced into the sewers, and that effect produced, must be cheaper than taking it out by the present mode by hand, independent of the disturbance of the surface of the street?—I do not know that it would be cheaper, for I consider that the body of water required would be attended with a very great expense, and when most required, as in the summer, would not be procurable.

Have you frequently complaints with regard to the emanations arising from the sewers?—We have complaints occasionally.

From the sewers with the invert at the bottom, and also the old sewers?—Yes.

Do not those offensive exhalations indicate that there are putrid accumulations in the sewers?—No; it is found frequently, where the exhalations are complained of, that they arise from the drains of houses.

Have you gully-holes in your sewers?—Yes.

Are not the exhalations from those offensive?—They are sometimes.

They are from the main sewers?—Yes.

All those emanations must indicate that there is putrid matter in these sewers?—Yes, frequently; but there are other sources of objectionable smell which are not putrescent.

Then the present mode does not relieve you altogether from those exhalations?—No, nor will any system.

Would any mode which would prevent that be an improvement on our method?—I cannot say that, for I do not think trapping, for instance, would be a good mode.

The question refers to the removal of the source of the emanations?—Any system that would improve the sewer is of course desirable.

You had been a Commissioner for a good many years before you were Chairman?—Yes.

Do you consider that one of the objects of the Commission of

T. L. Donaldson, Esq. Sewers is that of providing for the health of the district?—
Decidedly that is one of our main objects, but the general law of sewers does not contemplate that, nor give us powers to effect it.

Do you know anything of a Report in 1832 made to the Local Board of Health of the united parishes of St. Margaret and St. John the Evangelist, Westminster, at the time the cholera was raging? It states, "That by far the greater portion of these parishes is either without any common sewers at all, or that, where they exist, they are, from dilapidation or other causes, wholly inefficient to the extent; that 'it is dreaded some serious evils will arise:' the reports set forth that all the endeavours of the inhabitants to keep their vicinity clean and wholesome are frustrated for want of drainage, there being no common sewers, and this not rarely in crowded neighbourhoods, and public streets respectably peopled. As examples in proof, we may instance Strutton-ground, the line of way from the centre of Lower Westminster to Vauxhall, some small part of which, indeed, a sewer is said to traverse, its channel lying so far above the level of the floors of the basement stories of the houses, that they are constantly occupied by standing water, holding in solution the most disgusting and hurtful impurities, of which the greater part is without a common sewer. The following is the judgment of the visiting committee:—'In Strutton-ground we found the cellars deeply covered with offensive matter issuing from the neighbouring soil, and there are no means of removing it except by pumping during the night, which the magistrates have forbidden; we are of opinion that if some decided measures be not taken to remove the nuisance in this street, that a contagious fever of no ordinary malignity is likely to be produced.' In York-street and a part of James-street, through which the direct way from Westminster Abbey to Buckingham Palace lies, there is no common sewer, the privies are therefore disgorged into cesspools, which receive also the refuse water of the houses, and the mixture is therefore pumped or carried into the street. Occasionally this refuse water collects for a length of time in small drains or wells which also communicate more or less with the cesspools, becoming very offensive and the subject of general complaint. In lower neighbourhoods, where the inhabitants happen to be of a class that cannot meet the expense of carting away the accumulations in these cesspools, having either none or no effective drainage or sewerage, they empty the overplus of whatever may happen to consist in the street gutters at night, whence, as in York-street, it runs to the nearest grating, out of which is emitted an effluvia as powerful as it is disgusting and dangerous. In Rochester-row and the streets, &c., on the south or south-western side of Vauxhall-road, the stagnant ditches appear to be the universal receptacles, and from these unfavourable states of atmosphere there can be little doubt but that miasma of the most deleterious nature

issues; from the same cause, the total want of drainage, the fluids which soak out of and through large dung-heaps where horses and cows are kept, the site of which happens to be low, either stagnate on the surrounding surface or are carried out into soils to be added to the other noisome contents of the open street gutters; unmixed soil, in fact, has been observed stagnating in ruinous and badly-constructed drains, open for many feet together, to be at length absorbed by the surrounding earth, or to find its way into the deepest of the adjacent cellars. Such is affirmed by its occupants to be the case round two sides of the house No. 1, Vauxhall Bridge-road, who also complains of having, with the rest of the neighbours, for six years paid sewer-rates without having ever received any benefit." Then they go on to state other evils of the same nature with respect to a cow-house situated in Buckingham-yard. Is this a representation of the case at present, or have any efforts been made to remedy those evils?—Many of those evils have been remedied by the building of sewers since that period; others we are unable to repair. Had we the proper powers they would be remedied. We are very anxious to have powers to enable us to meet such exigencies.

The Report on Metropolitan Improvements was in 1838: what has been done with respect to those districts since that time?—A great deal of sewage has been done by private individuals; and the Court has done much, of which the various occupants of houses have been enabled to avail themselves. We are unable to build sewers in new lines. We cannot do that, unless we can call it a diversion of an old sewer.

You conceive you have not power to build a new sewer, however conducive to the state of the health of the district?—We conceive that we have not; but we have an idea of doing a great deal in Westminster, which has been hitherto stopped in consequence of our not knowing the nature of the extensive alterations which are to take place in that part.

You consider that you have not power to make a new sewer, however much it may be called for?—Not in a new line, unless under the circumstances above mentioned.

Have you power to compel the inhabitants to communicate with a sewer if it is made?—No.

You have not, then, the principal powers necessary to obtain the benefit of a sewer to a neighbourhood?—Not in many instances.

Are not those two the most important powers for that purpose?—They are certainly two important powers.

Do you know the district of Orchard-street and St. Ann-street; and are you cognizant of the condition of the sewers in that neighbourhood?—There is a sewer along Orchard-street, 500 feet of which was rebuilt in 1832; and another 500 feet in New Tothill-street and New-way, running out of Orchard-street, in the same

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T. L. Donaldson, Esq. year: 300 feet of sewer were also built in St. Ann-street about the same time, as a diversion of the old sewerage, which passed under houses.

Is there any sewer in the neighbourhood of the courts in the district round Orchard-street?—No regular and efficient sewerage.

Tothill-street is also in a very indifferent state, is it not?—There is a sewer, though an old one, the whole length of Tothill-street. We are contemplating doing a great deal there, but cannot proceed till we are aware of the plans for the improvements about to take place.

Are there any new sewers made in that district?—I know that there have been new sewers made there, but I cannot point them out. Upon the Report being made in 1832, the Court thought themselves justified in exceeding the powers of the law, and they built a long line of sewer in some parts of that district: 1000 feet were rebuilt along Dean-street and Great Smith-street at that time, besides the sewers in Orchard-street and the neighbourhood; and between 1824 and 1827 the outfall sewer in Wood-street and Little Peter-street was deepened and enlarged for a length of 1200 feet, and 400 feet diverted along Little College-street and Millbank-street.

Is there any sewer in New Pye-street?—There is no regular sewer along the street, but the houses are drained into an old sewer, which crosses the street.

Perkins-street, or Rents, and Old Pye-street, in which the paving and cleansing are in a most miserable condition?—I have been through that district lately, but whether I went through those precise streets I cannot tell. About 1000 feet of sewer were built along Old Pye-street, including the 300 feet built in St. Ann-street in the year 1832, and about 100 feet in continuation thereof to the centre of Strutton-ground, were built in 1838; and in 1840 about 2300 feet of sewer was deepened and enlarged, as an outfall sewer, in the Horseferry-road, and several hundred feet of collateral sewers were built.

It has been the object of the Commission to carry out such a system of sewers as shall relieve the district?—Certainly.

Is not this district, and has it not for a long time been, a most miserable district?—Yes.

Where are the sewers in this district?—I must refer to the surveyor for their particular situation.

In Brewers'-row, just across the road, the sewer is stated to be choked completely up?—I think there must be some mistake about that.

The houses are below the level, and therefore require a better drainage. Do you know Paradise-row?—I do not know its situation.

“Paradise-row; filthy, no courts in it; houses below the level;

unpaved, loaded with refuse ; no sewer carried down the whole of that populous district ;" and yet there is one in Artillery-row, close to it ?——Yes, there is one in Artillery-row.

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How comes this not to be remedied, if you are aware of it ?——Because we have no power to build a sewer, if there be not one already.

Have you applied for additional powers ?——Yes ; at the time of the Bill before Parliament, two years ago, the want of powers was mentioned.

Will you refer to any memorial the Court of Sewers in Westminster have made for new powers ?——It is in evidence before the Committee of the House of Commons in 1834, and is referred to in that Report ; and about two or three years ago there was a memorial presented to Lord John Russell and Lord Normanby on this subject.

The people have been suffering for many years in consequence of the state of the sewers, and the Commissioners wish to know what is the date of any memorial on the subject by the Commissioners ?——The date does not occur to me ; I will furnish it to the Commissioners.

Were there ever any resolutions passed by the Commissioners, stating that they had a deficiency of the powers requisite for the carrying out their drainage in this populous district, and requesting additional powers ?——I stated that there was a representation under the resolution of the Court, and that the chairman presented it to Lord John Russell and Lord Normanby on the subject two or three years ago.

Have the goodness to supply the Commissioners with copies of any resolutions passed by your Commissioners respecting your want of powers, and any memorial founded on their resolutions, if any such exist ?——Certainly.

Have the goodness to state what are the powers which you feel the Commission is in need of to give that efficiency ?——They are very few, and were embodied in that document which was presented to Lord Normanby, and a copy of which is already before this Commission.

You have spoken of several districts that are in a bad condition : do you know Frontage-row, where they are laying new sewers, at the back of Lady Dacre's gardens, in which the filth is thrown out into a heap, with a puddle running in front of the houses, sending forth a most dreadful stench ?——That part of Westminster is very deficient in sewage ; we are contemplating a good deal, but have been impeded of late years by the proposed alterations in those parts—we hardly know how to carry them out at present.

Do you allude to the line of street which has been contemplated between Westminster Abbey and Grosvenor-place ?——Yes, which would remove a great many of those evils.

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You would wish to carry your main sewer down that street?
——It would be very desirable.

Do you mean to wait till that street is made before you make a sewer?——No; but that being contemplated, it would not be desirable to make a sewer in that line, which might eventually be useless. We have received information from the Woods and Forests of the measures taken by them. In the neighbourhood of Buckingham Palace the property has been bought up, in order to make very considerable alterations.

There is another part, called Goodman-green, in which there are no drains of any sort, the earth heaped up above the level of the houses, and where a fever prevails constantly. Do you know Providence-row, which is a very filthy row?——I would beg to suggest that the surveyor would give much more accurate information upon these points than I can. I pretty well know the localities of the district, but Westminster is composed of so many small streets and obscure alleys, that I am not aware of each particular place.

You are not aware of the places referred to being in the state described?——Not as the names are given me.

There is, close at the back of the Great Bridewell of Westminster, a very populous district, and which appears to be totally neglected. Seeing the state of that, and hearing complaints, the Commissioners naturally inquire of you, as chairman of the Commissioners of Sewers, what is about to be done there?——We are building sewers, and have lately ordered sewers to some amount to be built from Buckingham Palace all the way round to the present sewers, for the purpose of diverting a continuous current from the King's Scholars' Pond sewer.

In your district there appears to have been no new sewer made within a very long period?——That is incorrect; but the surveyor can give the best information on that point.

Do you know Webber-street, on the other side of the Bridewell?
——No.

Do you know a large open sewer, 40 or 50 feet in length, with stagnant water in it?——As I have said, I am not aware of the particular localities. I know the general bearing of the place. I do not know such a street as Webber-street; perhaps Willow-street is referred to. There is an open sewer there, respecting which there has been a long question before the Court. Andrew Mann, the proprietor of the land, and the parish could not agree about the open ditch, but there is a regular sewer in the street.

In passing through Mr. Elliot's brewery you enter into Castle-lane, very near the Palace, which has several side courts, which appear to be in a most filthy state, and without drainage?——In a most lamentable state certainly. We have no power to get there. The landlords have done nothing for them, and we have no power to compel them.

Is the Strand in your district?——Yes, all of it.

Are you aware of the form of the main sewer which runs down T. L. Donaldson,
the Strand?—Our usual form. Esq.

With an invert at the bottom?—Yes.

You consider that that form is capable of cleansing itself?—
Yes.

The evidence of Mr. Leonard, surgeon, medical officer of St. Martin's parish, is to the following effect:—"What are the effects of accumulation of refuse in the sewers of your district?—The effects are very serious, giving rise to typhus, and a typhoid character to other diseases. There are times when the effluvia rising through the gratings in the streets are most offensive, not only to the neighbours, but to the public walking the streets. This is most perceptible after a shower of rain, just sufficient to damp the decomposing matter, or when the wind blows directly from the river up the sewers. I know several silversmiths and dealers in plated goods in the Strand and other parts of my district, who are seriously affected in their business by the evolution of immense quantities of sulphuretted hydrogen gas, which completely blackens their goods; and there are some parts of my district in which fever is always more or less present from this cause: indeed some houses are peculiarly subject to it." The next question to the same gentleman is, "Is there a large portion of your district, in which they have only privies or cesspools, which do not communicate with the sewers?—There is no sewer in Long-acre, except a small barrel-drain from Conduit-court to St. Martin's lane. Some of the cesspools are very large, and receive the refuse from several houses. One receives from five houses, and the drains running into it pass under workshops, rendering it almost impossible for the men to stand to their work. I know one house in which there is a cesspool below the kitchen floor, near the fireplace, and another in the back kitchen. There was one emptied at No. 51 about two years ago, and 32 cartloads of soil were taken from it. An immense cesspool also receives the refuse from all the houses in Long-acre, from the corner of Leg-alley to James-street, being Nos. 35 to 43 inclusive, and in James-street, Nos. 18 to 21 inclusive—in all twelve houses. It is of very great content, and not only occupies the whole area of a large backyard, but is four feet under some extensive workshops; and the corner of a house is founded upon part of the arching of it. When last opened, carts were employed constantly for a week to remove the soil; at the end of that time rods were passed down, but as no solid bottom was found, they were compelled to give over the task of clearing it out, and it was closed up again. At the end of Castle-street, nearest Drury-lane, a great nuisance also exists, almost every morning the soil being obliged to be cleaned out into the street; and in Drury-lane there are houses from which they are obliged to pump the foul water into the channel in the street every two or three nights. The sewer is in Castle-street, Long-acre, on the one side, and in James-street, Covent Garden, upon the other. The

T. L. Donaldson, Esq. houses in the several courts in Bedfordbury are badly drained.”
 —Very much so.

“Those also in part of Rose-street and Angel-court ; in the latter is a public privy, which is horribly offensive. Some houses in Taylor’s-buildings are also very offensive ; there is another public privy, I believe, there. There are several houses in my district which are scarcely tenantable from drains passing under the floors, which are only covered with timber. I have sometimes been obliged to leave them to breathe. In Broad-court, Cross-court, Duke’s-court, Martlett and Crown-courts, there are houses which at times are very offensive, from foetid odours arising from cesspools and drains.” You have stated that the main sewer in the street is formed according to your construction—a construction which you consider capable of cleansing itself. The evidence here states that the effluvia arising from that sewer is very offensive, and does much injury to trade, and is injurious to health. Are you ready to believe those statements are not correct ?——I should think they cannot be correct to that extent, and that they must be overstated. I am of opinion that some of the injurious effects alluded to by the goldsmiths must arise from the use of gas-lights.

You are probably aware that the public are often annoyed by emanations from the sewer into the street ?——I am aware that from some of the gratings of the sewers an unpleasant effluvia may occasionally arise.

The sewers in the Strand, you state, are formed on your improved plan ?——That depends upon the part of the Strand, large portions of the sewerage having been rebuilt within the last year or or two. If a complaint were made to us, we should tell them whether it arises from the sewers or the drains ; they are often mixed up one with the other by persons not acquainted with the subject. As to this complaint of Long-acre, it is a crying grievance—a grievance which we ourselves have not been able to relieve. A large part of the property on both sides there belongs to the Mercers’ Company, and they ought to lay out about 5000*l.* upon the sewers on their estate. We cannot get them to do so ; we have applied to them when complaints reached us, and have entreated them to send their surveyor to confer with us ; but although they receive an enormous rental from that district, they will not interfere : it is one of the serious evils of which we have to complain, and is particularly alluded to in the Report on the poorer districts, copies of which have been supplied to this Commission. In Bedfordbury we have lately brought up a sewer, but we cannot prevail upon the owners of property there to continue it.

It would be desirable, you think, that the Commissioners of Sewers should have the power not only of making the main sewers, but the collateral sewers, or compelling the inhabitants to do it ?
 —Yes ; I refer to the sewers, not the drains.

Would it not be also desirable that the Commissioners should

have the power of carrying drains to the houses?—If the power were given to them they would, of course, carry it into effect. I think it might be desirable that we should carry them up to the curb, not going into the houses or vaults.

T. L. Donaldson,
Esq.

It appears in your Return, that you paid 607*l.* for casting old sewers, 1336*l.* for cleansing, and 515*l.* for gully sewerage, making a total of 2458*l.* in 1842?—That was a heavy year.

You say, by degrees, by altering the shape of your drains, and getting a better fall, you hope to be able to do away with a great deal of that?—Yes; but the cleansing the gullies will, I think, remain about the same.

Would it not be desirable to adopt a form by which the gullies should clear themselves?—I do not think that can be.

Having no cesspools?—We have no cesspools to our gullies.

A sewer with a good fall should hardly require cleansing?—We find they do accumulate; we have an 18-inch barrel-drain, and still have an accumulation of matter.

If a sufficient supply of water, from whatever source derived, would cleanse those sewers, you would say that that would be very desirable?—Certainly. It would depend upon the expense of procuring the water.

Do you think that that body of water would carry away not only the soil, but also the scrapings of the roads?—I am not prepared to say that it would; but I think the usual showers in the streets will do that.

How are your flaps constructed; have they the power of shutting back the water from the river?—They are simple iron flaps, hung so as to keep shut while the water was not passing out.

Might not a dog's head, or some obstruction, prevent their being closed?—Sometimes even a slighter obstruction may prevent it.

And then the water enters?—Yes.

Do you not consider that that flap is susceptible of great improvement?—We have directed our attention to it, and shall be happy to see any improvement adopted.

Is there any register kept as to the state of the tide and the influence of certain heights of the water?—Yes.

Are there not districts in which there are arrangements made for putting down valves as the water rises, and lifting them as it falls?—No; we have nothing but those flaps.

Do you think it would be safe to trust to those flaps in places where it might be an object of great importance that water should never, by any chance, enter?—We have no other means of doing it: we use double flaps occasionally.

Do you know the average depth of the sewers in the neighbourhood of the Houses of Parliament?—No.

Do you consider that they are generally clean?—I imagine that they are pretty well.

C. L. Donaldson,
Esq.

Do you know how often they are inspected?—They are inspected whenever there are complaints.

Are you aware of the atmosphere, which exhales from those sewers in Charles-street, Duke-street, or Palace-yard?—When I go near them, I see whether there is any cause to complain; if so, I immediately send an officer to inspect them.

Can you state how recently those in Charles-street or Duke-street have been examined, or whether there is any system of examination?—There is no system of periodical examination of the covered collateral sewers. There are four surveys by the Commissioners of main lines of sewers every year.

There is no systematic inspection of the collateral sewers?—It would be impossible, and it is unnecessary unless there is a complaint.

Are you not aware that they might be in an extremely offensive state before the poor people will take the trouble of complaining?—Certainly.

What course of inspection is there over the district?—We have a surveyor, an assistant surveyor, and three clerks of the works; not enough certainly: we have about 140 miles of sewers, and it would be impossible for us to have a regular periodical inspection of them all.

Have you any open sewers in the district?—Yes, we have 15 miles.

How are they cleansed?—There is a man appointed on each line; he goes up and down it daily, and casts, where necessary.

In passing those open sewers, is the smell offensive?—Sometimes.

If there is anything in them, is it offensive in warm weather?—Yes; we are getting a system of inverts in all the open drains in the rural districts, to which I beg to call the special attention of this Commission.

Have you frequently complaints of sewers being stopped up?—Yes; on a complaint being made, it is entered in a book kept on purpose; and immediately the first officer who comes in, is sent down to see into it, if it requires immediate attention. If not, when the clerks of the works come in the evening, they take out the complaints which are in their respective districts, and are bound to make reports to the surveyors upon the complaints; or one of the surveyors visits the spots himself. It often turns out that the defect is not in the sewers, but in the private drains.

Can the surveyor effect an alteration without consulting the Board?—He can if it be urgent: he can clean a sewer immediately; he can remove the nuisance.

What is the amount of the rates?—It varies from 20,000*l.* to 30,000*l.* a-year.

It is laid upon the whole district by a pound rate?—Yes.

Are there any exemptions?—Yes, there are: the palaces

are exempted; the Houses of Parliament, the Courts of Law, and churches are exempted, because we cannot enforce the rate on them.

T. L. Donaldson
Esq.

Are the poor people's houses, which have no sewers at all, exempted?—No.

Are they not paying for the laying down of sewers from which they receive no advantage?—We assess all persons within the level or district receiving benefit, or avoiding damage; it is not necessary, according to the frequent decisions upon the law of sewers, that there should be an immediate advantage. The levy for the sewers is for the works on the district, not on those immediately connected with the tenement. If the party does not get an immediate benefit to his house, still he derives benefit from the general sewage of the district.

Can you state what proportion of the houses on which the rate is made receive no advantage from it?—No: all the houses not immediately draining into the sewers, of course, are not receiving direct advantage; but the reason is this—they pay for the maintaining the sewers which are already built. If we build a new sewer in front of their house, then they pay so much for the privilege of entering it, but no higher rates on that account.

Are they altogether satisfied with your reason?—Not always. We say that if the landlords had done their duty, and built a sewer, they would have been charged no more, and would have derived a direct benefit.

Were you aware that in the year 1834 a Mr. Peter Fuller presented a petition to Parliament against the state of your sewers, in which he endeavoured to show that very much disease and death arose from the state of your sewers?—I was not aware of that.

You are not aware whether any means have been taken to remedy the evils complained of by Mr. Fuller?—Those then brought forward have been examined into: we have considered all the points referred to in the Evidence before the Committee of 1834, and, as far as possible, we remedied them.

Mr. Fuller states, that nine cases out of ten of great fever arose in the houses near the gully-holes, showing that the gully-hole must be in a bad state.—I should question that; there may be instances in which a foetid smell may arise from the gully-hole, but I think a great deal of that evidence is very ideal, and many of the suggestions very fanciful.

Do you think the gully-holes are not nuisances?—I think if we could get rid of the gully-holes altogether it would be very desirable.

Have you been in the lower parts of Westminster, and not found that to be the case in every one of them?—No; I have found it in some, but not in every one. I always make a point in going through the streets to perceive whether there is any disagreeable smell; and wherever there is, I call the attention of the surveyor

T. L. Donaldson,
Esq.

to it, and direct him to examine the sewer. There are various circumstances which give rise to smells in sewers; for instance, if one is not connected with another at the end; and I have suggested to the attention of our Commissioners the importance of the connection between every one of our sewers, so as to produce an equable circulation of the air throughout.

Would you consider it desirable to discharge the foul air by a shaft?—I do not know whether that is practicable.

Is it not the case that wherever the tide has attained a certain altitude, every gully-hole in Westminster below the level of the tide, immediately begins to discharge upwards?—It is very possible; I am not aware of that.

Must it not necessarily be so when the sewers are below the level of the river? If the water pours down to the sewers, and the sewers have no exit to the river, from the tide being up, the air thus displaced must necessarily find its exit through the gully-holes?—Yes; and if it were distributed equally, I do not imagine there would be any great evil in that. There would be, at the same time, a great quantity of water, so that, of course, there would not be the same intensity of smell.

Do not you think it would be desirable to diminish the expense of constructing your sewers as much as possible?—If you can ensure equal capacity, equal solidity, and equal convenience of access.

Has there never been an instance of one of your upright sides failing by pressure from without?—Yes; if it is not properly constructed and properly filled in.

This is a plan of sewer, constructed under the superintendence of your own surveyor, at Notting-hill—(*the same being shown to the Witness*). Did not that fail?—That was from an error of the builder. We have very good evidence upon that subject; and I should very much desire that our clerk of the works should be examined. It was an error of the builder; our own contractor offered to build it, and to guarantee its durability. He has built within 150 yards, at a much greater depth and under similar circumstances, sewers that have never failed.

Was not the ground much drier where he built?—No; this sewer was re-built under the same circumstances with the other.

To what do you attribute the failure of that sewer?—It was not properly strutted. There was altogether insufficient strutting and planking, for directly the ground, which was a loose clay, was opened, it colted in, and therefore required extraordinary precautions.

Was the shape of the sewer sufficient to support itself without strutting?—It was capable of supporting itself when properly built.

That was built three times, was it not?—That was built twice: we soon found the man was doing it badly. It was sug-

gested that he had taken his contract too low, and was scamping it; and we put a clerk of the works upon it day and night, and he made them build the sewer, as it is now standing. I will furnish a copy of the evidence taken by the Court on the matter; but I am very anxious that the Commissioners should themselves examine our officers and contractors on the subject.

T. L. Donaldson,
Esq.

Do you consider that a straight side is as much equal to sustain pressure as a curved side?—Yes; built with brick.

You think a curved side has no greater power to sustain pressure?—No, for the difference of form is made up of soft mortar.

Have you not had objections made to the charge for the communication from the side drains into the sewer?—Rarely, for we only charge that which it costs us.

What is the amount you charge for the ring and the first three feet?—The charge is 10s. 6d. for the ring where one is not already inserted, and 10s. 6d. or 12s. 6d. for the three feet of drain nearest to the sewer.

Are there not frequently objections made by the owners of the humbler dwellings to the expense of it?—I am not aware of any.

Have you ever contemplated any mode in which that might be made in a less expensive form, or of less expensive materials?—We have, and we think it cannot effectually be done for less.

You think it is necessary to make the charge you at present make for the first three feet and the ring coming into the sewer?—Yes.

Do you think that if any less expensive mode, which would not be disadvantageous to your sewer, could be suggested, that would be advantageous to your district?—It would be advantageous to the poor and the rich too; the poor do not make the drains, but the landlords.

Have you not poor landlords who own those houses in many instances?—We have, of course, in some instances.

The price of the sewer seems the same whether for the poor or the rich?—Yes; taking the average, the cost of a sewer is a trifle in comparison to that of a house. Taking the ordinary expense of a house in London at 500*l.*, and the frontage at 21 feet as an average, the Court charges them for laying a drain into a sewer built by the district, 10s. a foot; that is, 10*l.* 10s. on a house which has cost 500*l.* building.

Take the case of a poorer tenement which has cost 60*l.*, with a frontage of 16 feet?—They would be charged about 6*l.* or 8*l.*

Then there is the communication from the house to the sewer besides that?—Yes; but that is not charged when we build the sewer.

Is the charge the same taking one house with another?—In some houses they have a larger drain than in others.

The charge on a house of 500*l.* a-year, and the charge on a

T. L. Donaldson, Esq. house of 5*l.* a-year is the same?—Of course; because it is for the work done for which we charge.

The charge for the opening to cleanse away the foul water is the same for a house of the smallest, as for one of the largest class?—It is for the work done. The question is not the value of the house at all; we merely charge them for the work done, and we should not be justified in doing otherwise.

And the work done must always be done in the same way?—Yes, it is done in the cheapest way for all.

No less expensive mode for the poor man's house has been suggested than that practised for the rich man's house?—No; no other mode has been suggested.

Have you tried any smaller drain?—We have tried all sizes; they cannot be less than nine inches in brick to make sound work.

Have you seen any burnt earthenware-pipe, glazed inside, of a less size than nine inches?—Yes, but then the saving would not be worthy of consideration; there must be a risk at all events in using them.

What is the cost per running foot of your second-class sewer?—I think 19*s.*; we have taken a medium charge to the houses on each side of a sewer of 10*s.* a foot; but the second size is rather the exception than the rule. It appears to me extremely desirable that, where there are no sewers existing, the Commissioners of Sewers should have the power to build them, and to compel the parties to drain into them. I am of opinion that it would be very just if one-fifth of the cost of building the sewers were to be borne by the district, on account of the dead lengths, and various other circumstances, and the advantage of a complete system of sewers to the public generally, and that four-fifths of the expense of building the sewer should be borne equally by the parties on each side of the sewer. The outlay might be realized in five years; I think five years is quite sufficient, for if you take a house which costs 500*l.*, that would be only ten guineas, and two guineas a-year might then be paid for the construction of the sewer, so as to liquidate it in five years. Lord Normanby, in his Bill, had provided that the parties should pay according to their respective interests—it was adjusted according to their interests, that a tenant having an unexpired term of seven years should recover the whole from his landlord; a tenant of 14 years should pay four-fifths; one of 21 years three-fifths; of 20 years two-fifths, and so on; the landlords to pay the remainder. By that means the whole could be repaid—the tenant paying it in the first instance, in five equal proportions, and deducting it from his rent as so much paid for the landlords. That appears a very simple system, and it would not be at all burdensome to the parties.

Will not it be very hard upon the tenant to make him advance that money in the first instance?—He would pay only the two

guineas per annum, if it is a house of large construction, and he would tender the receipt for that as part of his rent.

T.L. Donaldson
Esq.

APPENDIX No. 1.

APPLICATIONS to PARLIAMENT, &c., for increased Powers.

In 1770, Application appears to have been made for increased powers and jurisdiction, and to have failed in consequence of the serious opposition raised.

The Minutes of the Court, and also of the Special Committee appointed, the Bills, Petitions, Opinions of the Crown-lawyers, &c., are very long.

In 1807, The subject was again taken up, and a Special Committee appointed, the Minutes of which are also long.

Ultimately a Bill was introduced into Parliament, and the Act 47th George III., cap. vii., was obtained.

In 1812, A Special Committee was again appointed, and an application made to Parliament for the purchase of a Court House, and for enlarging the powers of the Commissioners, and the Act 52nd George III., cap. xlviii., was procured.

In 1832, A draft of a Bill appears to have been drawn, but no steps taken thereon.

In 1834, The attention of the Parliamentary Committee was called to the want of powers. (See p. 251.)

In 1837, A Special Court was called to consider a Resolution that a
13 March, Special Committee should be appointed to draw up a Memorial to the Secretary of State requesting further powers, which was withdrawn in consequence of the introduction of Mr. Ward's Bill.

In 1839, The Surveyors in reporting upon Dr. Southwood Smith's Fever Report observed, "that while the powers of the Commissioners continue to be limited as at present, the evils which are obvious must remain without a remedy." A copy of the Report was forwarded to the Secretary of State.

In 1840, A series of Resolutions, showing the powers required, was drawn up by the Chairmen of the several Commissions, and was forwarded to the Secretary of State by order of the respective Courts.

In 1841, It was resolved that this Court fully acquiesces in the necessity of legislation to carry out the objects contemplated by Lord Normanby's Bill, intituled "An Act for the better Drainage and Improvement of Buildings in large Towns and Villages;" but it is of opinion that the subject should be divided into two or more Acts, confining the sewerage to the Commissioners of Sewers.

That it is the opinion of this Court that additional power should be given to Commissions of Sewers, whereby authority may be given to compel all owners or occupiers of lands, tenements, and hereditaments, to drain their property into the sewers, by and under the order of the Commissioners of Sewers, and under the superintendence of the surveyors and officers of the Commissioners.

T L. Donaldson
Esq.

That it is essential to the carrying out of the objects of Lord Normanby's Bill before us, that the Commissioners of Sewers should have power to make new sewers, where no sewers exist (and where a jury shall find them to be necessary), at the cost of the owners of the adjoining property, in case such owners should fail to do so themselves; such new sewers to be afterwards maintained at the cost of the district.

These resolutions were forwarded to Lord Normanby, and a deputation waited upon his Lordship on the subject.

In 1842, It was resolved that the Chairman do confer with the Chairmen of the other Metropolitan Commissions of Sewers, with the view of their forming a deputation from the several Courts to wait upon Her Majesty's Principal Secretary of State for the Home Department, in order to urge upon the attention of Her Majesty's Government the importance of some early legislative enactment, calculated to effect the more efficient sewerage of the Metropolis, as contemplated in the Bill introduced by Lord Normanby.

Sir James Graham stated, that he had a Bill in preparation upon the subject, and declined to receive the deputation for the present.

The Court have frequently had occasion to address Parliament or the Secretary of State upon the subject of the invasion of their powers by the promoters of private and other Bills, and each Session much time is consumed in watching the proceedings upon Bills before the House. In 1837 a deputation waited upon the Home Secretary, praying the assistance of the Government upon this subject.

July, 1843.

THOS. L. DONALDSON, *Chairman.*

APPENDIX No. 2.

[SEWERS' OFFICE FOR WESTMINSTER, &c.—Extract from the Orders of Court, 3rd March, 1843.

THE surveyors reported, from the Book of Informations, that on the 25th February five feet of the north wall of sewer, being built by Jacob Connop, on the south side of Ladbroke-square, Notting-hill, had bulged in an inch and a quarter, in consequence of the water percolating through the bank after the rain and thaw on Sunday and Monday previous, the ground not being sufficiently strutted. That on the 23rd February the said wall was found to have been gradually forced over, until the width of the sewer was reduced from 2 feet 6 inches to 2 feet 3 inches; and that on the 3rd March instant, the last 12 feet of sewer built opposite Ladbroke-terrace did not keep its shape, in consequence of the improper mode of strutting the ground.

And Mr. Connop, and his surveyor, Mr. John Stevens, having been called into Court, the following letter was read:—

“To the Honourable the Commissioners of Sewers for the Westminster Division, &c.

“GENTLEMEN,

“I recently petitioned and obtained the permission of your Honourable Court to construct a sewer at Notting-hill in a new square now building by me, and intended to be called Ladbroke-square. During the progress of its construction it failed, as you are already informed; since

then it has been reconstructed, and has again, as I understand, failed. Being unacquainted practically with these matters, I have obtained the best information in my power as to the cause of failure, but find such authorities as I have been able to consult at variance. I am, therefore, desirous of trying whether an altered form of sewer may not succeed better; the more especially that I am suffering the greatest possible inconvenience, as well as loss, by the delay. I therefore request the permission of your Honourable Board to allow my surveyor to make such trial.

T. L. Donaldson,
Esq.

"I have the honour, &c.

"March 3rd, 1843."

"J. CONNOP."

The surveyors then presented a Report, as follows:—

"3rd March, 1843.

"In obedience to the order of Court, on the 17th of the last month, to report on the sewer building in Ladbroke-square, Notting-hill, by Mr. Connop, of No. 28, Dorset-place, Marylebone, we have to observe, that since the meeting of the Court on the 17th of the last month very little progress has been made either in continuing the sewer in question or in taking up and rebuilding the defective portions thereof; and we are apprehensive whether the parts which have lately been built will be found to withstand the lateral pressure of the banks any better than the portion which was first built, owing to the insufficient, unworkmanlike, and injudicious manner in which the work is proceeded with, more especially the ground-work.

"The persons who have contracted with Mr. Connop for building the sewer in question are by trade bricklayers, and, as we are informed, have undertaken to execute the same for 14s. per foot lineal, including digging and filling-in, brickwork, and every incidental expense—a sum so little above the actual cost of the brickwork alone, that scarcely any price is allowed for the digging, strutting, and filling-in the ground. Hence it arises that there is neither the necessary quantity or description of materials on the works for properly strutting and securing the banks.

"In the next place, the ground-men do not appear to understand the nature of the work, or to use effectual means (with what timber they have) to secure the earth, either in proper time or the proper place, to prevent the banks giving way, whereby great masses become detached, and act like wedges against the sides of the sewer before the ground is sufficiently filled in over the crown of the arch.

"The clayey ground through which the sewer in question is being carried is of such a treacherous nature, that more than ordinary precaution is required by strutting for its security, and which work, if neglected or omitted to be done well and expeditiously, so as to allow the banks to slip before the trench is sufficiently filled in, it is difficult to say how far the mischief to the brickwork may afterwards extend, more especially at this season of the year, when the land is full of water.

"Having requested Mr. Bennett and Mr. George Bird, the contractors with the Commissioners, to view the place in question, in order to have the advantage of their opinions as to whether there are any greater difficulties in the way of the sewer being properly built in that situation than what are occasionally met with in the ordinary business; their reply was, that they considered it only required proper care and precaution to be observed in digging out and refilling the ground over the sewer; and that they should not hesitate to execute in a sound and substantial manner a given length of the same sewer, in any spot where the earth had not been previously disturbed, after the rate of 17s. per foot lineal.

"With respect to those portions of the sewer which are ordered to be taken down and rebuilt, we would suggest, in consequence of the wet and rotten condition of the ground along the sides thereof, the expediency of allowing them to remain until, by the advance of the season, drier weather

T. L. Donaldson, Esq., may be expected, when the work may be proceeded with with much less difficulty and expense. But at the same time, if the rebuilding the defective parts should be postponed as suggested, we would submit for the consideration of the Court the expediency of suspending the leave granted to Mr. Connop for building the sewer in Ladbroke-square until the whole of the defective lengths are rebuilt in a satisfactory manner.

“JOHN DOWLEY, *Surveyor*.

“WILLIAM DOULL, *Assistant do.*”

And Mr. Joseph Bennett and Mr. George Bird, the contractors of the Commissioners, having been called into Court—

Mr. Bennett stated that he had seen the spot; that he had executed similar works; that the whole cause of failure was want of judgment in the builders of the sewer; that if the ground had been properly strutted, the accident would not have occurred; that the soil is peculiar; it crumbles when the air meets it, and is as bad as a running sand when disturbed. Considers that in this case it was not the form of the sewer at all that was in fault; whatever form had been used, it should have been properly strutted, or would have failed; any form would have yielded. Would take any contract (with the Court), and guarantee the sewer for twelve months, in a similar situation, where the ground had not been moved.

Mr. Bird confirmed the above; and said that, 50 feet off the place where the sewer had already failed, he would build a sewer at the same depth, and guarantee it for one or fifty years, at 17s. per foot run. Where the sewer had failed, the parties building it had so strutted the ground as to have a tendency to act as a wedge at the foot of the sewer.

Mr. Bennett said that if the parties went on as at present, they would endanger the houses already built; they had excavated for the private drains from the houses (second-rate houses) through the treacherous soil of the banks before they had completed the trench for the sewer, and so taken away the power to strut the sides of the trench. They have now nothing secure to strut against.

Mr. Bird confirmed the same.

Mr. Connop observed that his surveyor (Mr. Stevens) would put down a sewer in the part that had failed, and without struts in the sewer, where the contractors declined to do it.

Mr. Bird said he would willingly do it in the way he supposed Mr. Stevens would do it, namely, by removing the weight off the banks.

Mr. Stevens stated that, in his opinion, the soil was not disadvantageous when the sewer was once properly built. He described his ideas of the pressure of the ground when semi-fluid, as in this case. He then presented the form he proposed to adopt; and stated that he desired to build, as an experiment, about 30 feet of sewer in the worst part of the ground where the sewer had failed.

The question was then put from the Chair, whether Mr. Connop's request should be granted; and, after a long discussion, it was

Resolved, *nemine contradicente*, That the request of Mr. Connop be not granted.

Resolved, That the part of the sewer which has failed must be taken up and rebuilt, but that Mr. Connop have permission to continue the sewer now building on the south side of Ladbroke-square, east of Ladbroke-terrace.

Mr. Connop was then called into Court, and informed of the decision of the Court.

MR. RICHARD KELSEY, examined.

ARE you surveyor to the Commission of Sewers for the City of London?—I am. Mr. R. Kelsey.

You have been so for some time, have you not?—Since November, 1832.

Are the sewers generally in your Commission in a good state?—Yes.

Has there been much improvement made lately?—Since I have been surveyor I have had the construction of 23,483 yards, in 185 different places, amounting to 13 miles and 603 yards. In the last 10 years above 121,000*l.* have been expended in new sewers (App. No. 1).

Are those new sewers, or substitutions for old ones?—Almost all new, but some of them substitutions for old ones.

Can you distinguish the new ones, and those which were substitutions?—I have not distinguished those, but I can do so if it is desired. It may possibly be a matter of curiosity that between 1756 and Christmas 1832, which is 76 years from the time the Commission commenced building sewers (before that time they were built by individuals), there were only 9 miles and 1038 yards built.

Up to 1832 there was a great deficiency of sewerage?—There was a deficiency.

In 1834 a Committee of the House of Commons sat on the sewers of the metropolis, before which you were examined?—Yes.

Since which there has been a great improvement?—Yes.

Have not the Commissioners altered their rules which required persons asking for sewers to contribute a portion of the expense?—I do not know that I can refer to the exact time, for it arose gradually. There was not a distinct alteration until the present year, when it was determined that in all cases the Commissioners would build sewers without contribution, but there are several instances of the Commissioners having built sewers without contribution before—for instance, the whole line from Lawrence Pountney-lane to Earl-street, along the whole front of the Thames, was built without contribution. The Commissioners consider it as a base line.

What was the general rule previously?—To require that the parties should pay one-third. This alteration took place gradually. Very many years back the Commissioners required two-thirds to be paid—I speak of 50 or 60 years back—it was subsequently lowered to a half, and then to one-third.

That has been determined within the last 12 months?—Yes, only that for the last three or four years, in what were considered matters of moment, or where the neighbourhood was very poor, or

Mr. R. Kelsey. where it was more matter of public benefit than to individuals, they took upon themselves the whole charge.

Did they take into consideration the health of the population? —Yes; in Bear-alley, Farringdon-street, there had been a drain in an alley which had formerly communicated with Fleet-market, but which had been stopped up, and which was considerably below the level of the public alley to which it communicated. This was a private place, but tenanted by very poor people; the landlord appeared to have been exceedingly inattentive; the medical officer of the district called upon me on the subject; I took the liberty of mentioning this to the Commissioners, and they ordered me to make a survey for a sewer.

You considered it a matter within your duty to build sewers with reference to the health of the people?—Unquestionably.

You pay for the sewers by a rate on the whole of the City of London?—Yes.

What rule do you make with reference to carrying out necessary improvements, the sewer being made at the general expense of the rate-payers? Suppose there are two or three different places, all standing in need, do you carry them on simultaneously, or in what way do you determine which to take first?—They are carried on as much simultaneously as possible, according to the means of attending to them on the part of the clerks of the works. A man cannot attend to more than two sewers at the same time—he can attend to two if within a moderate distance. And also with reference to the interference with trade—for instance, I have to build a sewer at the lower end of Shoe-lane, but I am obliged to defer commencing it on account of the trade of Fleet-street, which would be interfered with by stopping the carriage-way.

Have you a general plan of the whole of the sewage?—That before the Commissioners is a general plan.

Upon this plan, or any other, is there a mode by which you can state the comparative levels of the district?—Not upon the plan.

Have you any mode in which persons can ascertain that?—No; but if they come to me I have a memorandum by which I find the general levels.

In making this system of sewers, is there any reference had to the general level of the district, so that main lines shall be taken up?—No; that has been the object of the Commissioners—for instance, in deepening the sewer from London-bridge to the northern boundary of the City, that has been done with reference to the general advantage of the city, combining with that the object of improving the county drainage.

In some of those districts has there not been great improvement made lately. In the vicinity of Bishopsgate-street, which is a very poor district, for instance?—Yes.

Till very recently that populous district must have been in a very neglected state?—Yes; it had only surface-drainage.

What was the reason that populous district was not attended to till very recently?—The Commissioners had to work their way up from London-bridge, so as to be enabled to do away with the sewers of Moorfields, which were but just below the former surface. They could not carry it forward in those streets till they had been enabled to make a new sewer, for the express purpose of lowering the drainage.

Mr. R. Kelsey.

In what way can any person ascertain the fall from a particular district?—I have my book containing memoranda of the different levels which have been made throughout; it has never been marked upon the plan, with reference to any definite point.

There being an old sewer along Houndsditch, and another ancient sewer along Bishopsgate-street, what is the reason the crowded localities in that neighbourhood have not been begun to be drained until recently?—One reason may be that the Commissioners were desirous of not burdening the rates too heavily, having to expend their money over the whole district. The next and most material was that the body of the land falls westward from the sewer in Bishopsgate-street; that being only 12 feet deep at Sun-street, they could not drain any distance westward into Bishopsgate-street. The first object was to drain Moorfields, and then to improve Bishopsgate Ward. The sewer in Sun-street is about eight feet deep; the sewer I am now making, crossing Sun-street, is much lower (six feet nine inches). The Commissioners were willing some years ago to build a sewer in Half Moon-street, intending to drain that into Bishopsgate-street, in the best way they could, if the inhabitants would contribute 50*l.*, but they would not.

Do you think it necessary that the Commissioners should have some power to compel the inhabitants to contribute in such a case as that?—I have always felt that would be a very desirable thing; but now the Commissioners do it without requiring any contribution.

You said you had maps of your district, on what scale are they?—The large ones are 30 feet to seven-eighths of an inch.

Is this the largest general map you have?—No; I have another which covers something like 12 sheets; I cannot recollect the scale.

On what scale are the partial maps?—30 feet to seven-eighths of an inch.

Have you any marked levels for those drains?—No.

Have you any datum line from which that is usually calculated?—No, they have been generally taken from the line of Lower Thames-street and Upper Thames-street, being the lowest ground.

You have no absolute datum by which you are regulated throughout that district?—No; the new sewers have been worked up generally from the shore of the river. The water-bed of the mouth of the London Bridge sewer is coincident with Trinity

Mr. R. Kelsey. low-water mark. They have been worked from the mouth of the ancient sewers and docks, which were often down to the bed of the river.

You have no bolt or bench mark in any part of your district, by which to compare your levels at any given time?—Only the mouths of the sewers.

Have you a bench marked in the area of your district to which you can refer the levels of the sewage?—No, we have not.

Do you think that contour lines would be useful on maps representing the sewage of the district?—Yes, they might.

Have you ever seen those laid down on the Ordnance maps?—No.

Do you not think such contour lines as have been adverted to would enable you to regulate your sewers better?—If the place was about to be drained they would, but the sewers are in existence from which we work.

Do you not alter the lines of your sewers?—They have been altered.

Can you at any given time tell what exact height you are above the mouth of any one of your drains?—Only by reference to the rise of the surface.

Are you not doing fresh work?—But our depths are such that there is perfect power to drain the whole district. There is no part but what is capable of being drained, and which will be drained in a very short time.

You have no means by maps or section by which it could be known what is the depth of your drain at any particular point?—No; I have not that, as below or above any given line, because it has never been necessary.

You keep no account of that?—No; it has never been necessary, and therefore it has never been done; but all depths below the surface are marked upon the large maps in the office, and recorded in the book.

Do your books give you the lines of levels of different sewers; and can you tell by reference to any book the level of any particular sewer?—No; I can only give the depth under the surface, and by referring to the falling line, of which I have a memorandum. I could do it by calculation; I could not do it off-hand.

Suppose you wished to ascertain the fall there is between a particular point and the outlet, could you find it by calculation?—Yes.

Do any other districts drain into yours?—The Holborn and Finsbury, and the Tower Hamlets, to a very small extent.

What means would you have, supposing they were desirous to construct a new set of sewers to deliver into yours, to afford them the necessary information?—If the surveyors applied to me, I would give them the depth of the outlet immediately.

Would that be from documents existing at the office, or from your own personal information?—From my own personal in-

formation, and the documents existing at the office. The depths of all those sewers from the outlets are recorded in the office. Mr. R. Kelsey.

But not from any datum line?—No; that has never been felt to be necessary. It could be done.

The surface varies from time to time?—Yes. I think the following paper will fully prove that.

STATEMENT of the alterations of the surface of the City of London.

Thickness of made ground :—

	Ft.	In.		Ft.	In.
Paul's Wharf up to St. Paul's Churchyard	9	0	to	12	0
Watling-street	11	0	,,	12	6
Bread-street	17	6			
Cheapside; the natural earth was not reached. The cutting varied from	14	0	,,	23	0
Gracechurch-street	14	0	,,	18	0
King William-street	12	0	,,	17	6
Princes-street	10	0	,,	33	6
Moorgate-street	16	6	,,	21	6
Fenchurch-street	15	6	,,	17	10
Bishopsgate-within	9	6	,,	16	0
Fish-street Hill	5	6	,,	18	10
Eastcheap	12	0	,,	15	0
Redcross-street	7	0	,,	0	0
Barbican	10	0	,,	13	0
Cannon-street	9	0	throughout.		
Rosemary-lane	8	0	,,	12	0
Water-lane, Fleet-street	5	0	,,	9	0
Cateaton-street and Lad-lane	12	0	,,	14	2
Streets in Cloth-Fair	4	6	,,	12	6
Streets in St. Ann's, Blackfriars	4	0	,,	13	3

The plinth of Temple Bar is buried in accumulation.

The east end of Newgate-street was lowered about 12 inches when the Post-Office was built.

London Wall has in part been raised above two feet within the last 25 years.

The Pavement and Little Moorfields have been wholly re-arranged within the last 10 years.

All the improvements from London Bridge to London Wall have largely altered the surface of the main line, and of the adjacent street.

The north side of Holborn-bridge has been raised about two feet.

Such occurrences as these might be noted in some way, but the insensible alterations are equally great, as, for instance,—From levels taken in 1770 and 1842, it appears that in Bishopsgate-street Without, at Bishopsgate Churchyard, the surface has risen two feet two inches in 72 years, but at Spital-square only 12 inches in the same time.

The result of this examination of the surface is confirmed by the depths of the sewer, as originally built, and as they now measure.

Therefore it would require to be verified from time to time? —Yes; it is constantly changing.

The relation between the surface and the sewer is constantly changing?—Yes; that would create difficulty as to regulating by Trinity high-water mark; its surface is always changing.

A bench mark would remain?—Yes; that could be provided for if it was desirable.

Can you tell, on inspecting the map, which way the water falls

Mr. R. Kelsey. in all the drains represented?—I could tell, because I know it; but no stranger could tell. On the large maps it is marked. It is not noticed here, because it was felt it would lead to confusion.

Why would it lead to confusion?—Because it would be making the map more complex; that is the only reason it is not done.

Would it not give greater facility in examining these maps to have the currents indicated by arrows?—It might be done. It did not occur to me when I made this, it being for the general use of the Commissioners.

What is the rate of fall upon that new sewer of which you have spoken?—It varies: some parts are about half an inch to ten feet.

Is there any physical reason why that should not be the case from the beginning?—It might be so; but it was not considered necessary to get a greater depth than would suffice for the drainage of the county. At the north end of the Pavement, Moorfields, the depth of the main trunk is 27 feet.

You consider that rate of fall a good fall?—Yes; the water runs from Moorgate-street at such a rate that I cannot stand against it. It all depends upon the quantity of water. The same fall with a small quantity of water will be sluggish, when a large quantity of water makes a torrent of it.

Do you pay attention to the uniformity of fall in carrying up your sewers?—No; we only give the fall which is requisite to obtain sufficient depth to provide for the lowest basement. I never like to be less than 12 feet from the surface at the head of a branch if I can avoid it.

Do you find any accumulations in the sewers?—We do find accumulations, but very little indeed. There were large accumulations in old sewers; but generally speaking, the sewers cleanse themselves.

Do any of your sewers meet at right angles?—Yes; some of the old ones.

Do you endeavour to obviate that mode of meeting as much as possible?—Wherever I can. Where a small sewer joins with a large one, and it happens to be a foot or two, or more, above the water-bed of the sewer, I do not consider that it is then a matter of any moment if it falls perpendicularly.

When two sewers meet, supposing the direction of the main sewer and the direction of the tributary to be at right angles to one another, and they must meet, how would you arrange the actual meeting?—The actual meeting may be eased even if they meet at right angles, by curving the bottom of the sewer downwards, which turns the water down easily.

Do you endeavour to obtain a current of drainage from the tributary into the main drain in the line of the main drain?—[The witness produced a plan for the addition to the City of Edinburgh from the Carlton-hill to the Links of Leith, made by

him, in competition, thirty years since, with the suggested system of sewage; and also a plan, made early in 1832, of the projected sewers from London Bridge upward into Bishopsgate and Bread-street Wards, and pointed out that there was not a single instance throughout of a right-angled junction, all being either in acute angles or in curves of large radius.]

Do you, in practice, in the City of London, follow that system? —I do.

Are you of opinion that the only good mode of connecting one sewer with another is by bringing them in curved lines, so as to make the line of the current of the collateral sewer coincide as much as possible with that of the main sewer?—It is such a common-sense principle that I only wonder that any one can have departed from it.

Do you show upon this plan the connections with the different houses?—No.

Would it not be advisable to do that?—It could be done in the course of time, but it would involve great labour. My inspector has a memorandum of every private drain. He has a memorandum of the outlet of every drain in the City.

But inlets to these are made under the direction of the Commissioners of Sewers?—In the new sewers they are, but this is a very old line. The regulation of the Commissioners of late years has been this:—finding that there was a great deal of difficulty in getting individuals to make the drains substantially, the Commissioners have required, that their own tradesmen should be employed to do the whole up to the front of the house. Since that plan was adopted, in 1832, every drain, excepting those which have been made surreptitiously, has been constructed by their own workmen.

What is the charge?—5s. 6d. a foot.

What is the size?—15 inches.

If you had a plan of this kind marked, you would be able to state that such and such a drain had been made surreptitiously? —My inspector can do that from his book. There is no street in the whole City with respect to which I have not memoranda of the surface.

You state that you do not make any drains at right angles when you can avoid it?—Not generally.

Would you make any at all?—Not willingly; except, for instance, in Moorgate-street, where the fall is very great.

Do not you consider that even there you would have an accumulation of matter?—No; by curving the lip of it downwards you get rid of that, and it runs down the side; indeed the current is so great that it is impossible that anything can lodge: it would be swept away immediately.

What do you consider a good sectional form of sewer for a main sewer?—If you have a semicircular top, and a semicir-

Mr. R. Kelsey. cular bottom, and straight sides, I think that all the conditions of a sewer are answered.

What are the sizes of your main sewer, specifying the altitude and the diameter of your semicircles?—Our main sewers are very large. The London Bridge sewer is 10 feet by 8 feet, and that is oval at its commencement, and it terminates at Moorgate-street 8 feet 3 inches by 6 feet 9 inches.

Do you divide the sewers into classes according to their size?—No; the smallest-sized sewer that the Commissioners make in a long street is 4 feet 6 inches by 2 feet 6 inches on the average. The other sizes are 5 feet by 3 feet, but there are several considerably larger than that, where large quantities of water are expected to come in from the Holborn and Finsbury division. The outlet I have for the main sewer at South-place is 6 feet 6 inches by 4 feet 6 inches.

How did you calculate the size necessary for that outlet?—The reasons which induced me to adopt that size are contained in the following statement:—

The Bishopsgate-street sewer, which receives the waters of Shoreditch and adjacent places, being 5 feet by 3 feet, and opening into the Irongate sewer, which averages 8 feet by 3 feet 8 inches, is at times overcharged, and pours back the upland waters.

The sewer in Walbrook and Dowgate-hill, which received waters from the Finsbury division, was built 5 feet by 3 feet. It was destroyed in 1821, and the houses endangered by continual overcharges from the upland district.

The ancient Walbrook, which, at the most, drained the lands south of Islington and Ball's Pond, &c., must have been much more capacious than the present Fleet sewer.

The Fleet sewer, which drains the hollow land south-westward of Highgate, is 18 feet 6 inches by 12 feet at the mouth, and 12 feet 3 inches by 11 feet 7½ inches at the City boundary. This has often been surcharged; and only within the last year, the culvert, so ably constructed at its mouth by Mr. James Walker, was severely injured by the flood consequent upon a thunder-storm.

The sewer from Moorfields to Holloway appears to measure upon the map about three lineal miles. In process of time, and as buildings increase, it may throw out branches in all directions, and the three miles may become thirty. Not only all the atmospheric waters which may, upon an average, fall within the valley south-eastward of Highgate (or at least a large portion of them), but all the artificial supplies which the wants of its yet future inhabitants, as well as of those intermediate between Islington and Moorfields, may require will have to be carried off by the City sewers.

In anticipation of this, and knowing the disadvantages attendant upon sewers of too small capacity, not only has this large sewer been provided, but it has been kept 18 inches deeper than the Wilson-street sewer, so that that may be hereafter deepened should circumstances require it; and preparation has also been made for the reception of an auxiliary sewer, of equal depth, at the City boundary by Finsbury-place.

Understanding by the term "data" ascertained facts upon which to raise a calculation, there are none; but I think there are sufficient results of experience to justify the precaution taken by me.

As some proof that I am not altogether without justification, I beg to observe that, since the work was begun, Mr. Roe has informed me that the

water has risen in one of the shafts in Wilson-street 7 feet above the crown of the sewer, although the Eldon-street sewer is 5 feet by 3 feet 2 inches, the London Wall Sewer 6 feet by 4 feet, and the main trunk increases from 8 feet 3 inches by 6 feet 9 inches to 10 feet by 8 feet at its mouth.

With respect to the sizes of the sewers, you have mentioned three; have you any others?—For courts and alleys 3 feet by 2 feet 2 inches; that is the average dimension: and in proportion to the number of the houses I sometimes make them 4 feet by 2 feet 4 inches.

You generally proportion the size of the sewer or drain to the quantity of drainage?—That is the general object, and the maxim of the Commissioners is never to make any sewer so small as that a man cannot get into it easily. I laid before the Commissioners, soon after I became their surveyor, a report (App. No. 2), mentioning the dimensions into which the human body could be conveniently doubled, which I recommended to form the smallest size; and they were pleased to adopt that, and that has since been their practice.

What is the minimum size?—3 feet by 2 feet 2 inches.

The necessity for having the sewer so large that a man may get into it presupposes accumulations in the sewer, which are required to be cleansed out?—Yes; in small lengths of 400 or 500 feet accumulations may occur, though it is a long while before they do, which have to be cleared out at times, and at all times they will have occasion to be examined.

Have you made any observations with reference to the quantity of water flowing down the sewers at any time?—No.

You say that some of your sewers are elliptical, or egg-shaped, or oval?—They are true ellipses some of them. Inclined sides have been largely used. They were introduced by my predecessor prior to 1823.

What is the average cost of your sewer of the size 4 feet 6 inches by 2 feet 6 inches?—It varies much according to the situation, according to the depth, and according to other circumstances, such as the danger of execution.

What are the dimensions of the brick-work?—14 inches all round.

Do not you think that is heavier than necessary?—I do not like to trust anything else, I think the Commissioners of Sewers ought to build, as it were, for ever. The following is a—

STATEMENT of Failures which have, apparently, taken place in consequence of the insufficient strength of Sewers.

The Fleet-street sewer, built in 1668, and varying in size from 4 feet 3 inches by 2 feet 6 inches to 4 feet 9 inches by 3 feet, and (as I recollect is noted in the record of it) built with 9-inch walls and 14-inch contrefortes at intervals, fell in, at three separate places, in 1715, 1725, and 1739, and was rebuilt with 14-inch walls.

The sewer of Ludgate-hill and street, built soon after 1666, and varying from 4 feet 2 inches by 2 feet 9 inches to 4 feet 6 inches by 3 feet, was

Mr. R. Kelsey. repaired, in 1729, from St. Paul's Churchyard down to the Fleet Ditch, "the great part of the walls having fallen in and the paved bottom washed away." In 1822 it again failed, and great part was rebuilt and enlarged.

The sewer in Walbrook fell in (1821), and a body of earth 8 feet square and 16 feet high was washed away.

In 1838 part of the sewer in King-street, Smithfield, fell in, leaving a space from the kerb on one side home to the wall of the houses on the south-east side.

The 19th Charles II., cap 3, sec. 46 (1667), the Act for Rebuilding the City of London, now repealed as to sewers, directs that sewers 5 feet high and 3 feet wide shall have side walls $1\frac{1}{2}$ brick thick, the top arch 1 brick on end; the bottom to be paved plain, and then 1 brick on edge circular.

The ancient brick arch of the Walbrook sewer, in Lothbury, was $1\frac{1}{2}$ brick thick, having stood about four hundred years, until destroyed in 1834.

What is the cost?—The Commission take a tender for the whole work; there is no division. They do not take it at per yard, but it is for the whole work; they take a general tender; the whole is done for so much money, which includes everything that is to be done.

Is it done so in repairs?—In repairs it is done by day-work. New gullies are measured where it can be done.

Do not you think it would be possible, by altering the shape of those sewers, to make 9-inch brick-work answer where you now put 14-inch brick-work; that is to say, make a cheaper and at the same time as strong a sewer?—I think not. I do not feel myself justified, as an officer of the Commission, in recommending them to do that which, if they went into a court of justice, they could not justify.

Do you employ what is called flushing?—Never; only making a little dam, and letting out the stuff, and flushing it off; but we have no apparatus.

Do you think that deposits are more liable to accumulate in a sewer with a flat bottom, or in a sewer with a curve of a larger radius, than in a sewer with a semicircular bottom?—I think, very little indeed; it all depends upon the quantity of water. If you had a sewer with a flat bottom, and plenty of water in it, it would wash it out.

With the same quantity of water going through the two, which would be most likely to accumulate deposit?—The flat bottom with the same quantity of water.

What is the usual size of the drains that lead into sewers?—15 inches the least.

Are the materials of which they are built apt to become porous in course of time?—They are good stock-bricks.

Do you know practically whether water oozes through them, and affects the ground adjacent?—I think very little indeed; it might possibly be the case in some very old drains built of place-bricks, but not with regard to any that have been built within my knowledge, nor I believe any built by respectable builders.

Are any of your drains exposed above the level of the ground
—No.

Have you noticed any such drains in London?—No; the only ones I ever saw above ground were those in Moorfields before it was built upon, and which were even with the surface, because it was intended to raise the ground over them.

How were they covered?—With brick arches.

Do you know of any open drains in London that stand above the level of the ground?—Not in the City.

The question refers to drains of houses?—I think I could mention one which has been exposed, but which is covered by the floor of the basement story; that is one that was built by St. Bartholomew's Hospital long before the Fire of London, which passes under the houses in Hosier-lane, and that is covered with the floor of the houses, but it is covered substantially; it is not open at all.

Do you happen to know whether there is any smell through the structure of the drain?—Not through the drain itself; but unfortunately that sewer being exceedingly ancient, and being built over by very old houses, has been exceedingly ill-used, so much so, that in endeavouring to rout out all the sewers, in order to make a plan, we found part of a bedstead in that sewer, and we have even found dead bodies, or at least coffins, in sewers. In one which passed under a churchyard we found that it had been used for sepulture; that they had broken into the sewer and put bodies in it.

Who do you imagine had done so?—The sexton or somebody, surreptitiously. The sewer passed through the graveyard; that was the case of the old town-ditch: and there is another, a private sewer, which was only discovered by having permission from St. Paul's Cathedral to turn the surface-water into one of their drains. It was discovered that they had buried the beadle of the parish in the sewer. Perhaps, being dry, it was supposed to be an old vault, and in all probability was a mistake; but in Cripplegate churchyard my inspector discovered in his explorations that the sewer had been broken in,—two ledgers (*i. e.* flat tombstones) placed upright at each end, and some six or seven coffins deposited—some flat, some endways. They were immediately removed, and the sewer made good.

Do you happen to know any drain which, covered only by the floor of the house, appears to be sound and well made, but through which offensive evaporations pass?—No; I have no knowledge of any.

Do you think the ordinary cement would prevent the passage of effluvia?—That would be my impression.

You have stated that in some instances the drain passes through a churchyard; have you observed or smelt, in passing through the churchyard, a peculiarly disgusting smell from the emanations from the churchyard?—Not that I have observed. We have three that go through churchyards, but it has never been complained of. I have not perceived anything; but I am a very incompetent witness upon this subject, for I cannot smell.

Mr. R. Kelsey.

Mr. R. Kelsey.

Is there a drainage from the churchyard into your sewers; from the surface-water percolating the ground and then going into the sewers?—I do not imagine that there is.

Do you cleanse some of your drains by hand?—Yes, the whole.

What is the annual cost?—The accounts are made out half-yearly. I have extracts from them, from which it appears that they amount, upon an average, to 469*l.* a-year. But that I must beg leave to explain to the Commissioners, because it is a matter of great moment as regards this inquiry. This cost has arisen from the circumstance of the Commission having directed a plan to be made. It was necessary that all the ancient sewers should be explored. Many of them were found completely choked up; no one could tell how long; and before the men could pass through they were obliged to be cleared out. They are now made clear, and probably it will not cost one-third of this in future years.

Has it been 469*l.* each year?—The whole has cost 4689*l.* in ten years; but it is very probable that they will not cost one-third of the money hereafter.

What is the contract price per yard for cleansing the sewer?—About 3*s.* 11*d.*; and cartage, which is 4*s.* 2*d.* upon the average, the double load.

That is to say, 6*s.* per yard?—Yes; and to this the cost of opening the man-holes and fencing in and watching has to be added. The quantity has been 15,143 yards in the ten years.

Have you any account of the expense previous to the last ten years?—No, I have none; the account was not kept so systematically as to enable me to state it.

Have you no account from which you can find what the expense of cleansing the drains was previous to those ten years?—No; the cleansing and repairing were blended together.

You have stated that there are a few accumulations in the sewers. Within the last few months there has been a great deal of evidence taken from medical officers, and your attention is requested to the following statement in the evidence of Mr. Thomas Abrahams, a surgeon. He is asked, "Are you aware that decomposing matter is allowed to accumulate in them?"—He says, "Yes; very recently they took up the refuse in our street, Old Broad-street; it smelt very badly, and it was black and horribly filthy." He is asked, "How long before had the sewer been cleansed?"—I do not know; I do not remember its having been cleansed before the last September since I have been there, which is about nine years.—Do you remember to have perceived the smell from the sewers before the last September?—Yes; there is a gully-hole near my own house, from which there was constantly an offensive smell: it is much worse after a thaw in winter, or a shower of rain in summer. A neighbour, living two doors from me, being more annoyed by it than I, made great efforts, and at length succeeded in getting it

trapped; and I have not since perceived any smell from it, though I observe it now in other places. The gully-holes are trapped now in most of the respectable streets, but in the bye and poor streets they are not trapped." He is then asked, "From the evidence which has come before you, have you any doubt that the existing state of sewers in the City is the latent cause of much disease and death?—I have not the least doubt of it in the world. A great deal of active disease, which creeps on gradually and insidiously, may be traced to that cause." Do you consider that a correct account?—I think I can explain that. Last September the Commissioners were about to repave Broad-street, and they always take advantage of the repavement of a street to trap the gullies; and when the gullies had to be trapped, the sewer was cleansed out, as a matter of course, to commence with.

Mr. R. Kelsey.

It might not have been cleansed for nine years before?—No.

Mr. Henry Blenkarne, a surgeon in the City of London Union, is asked, "Are you aware that in respect to sewerage it is the practice to allow deposits to accumulate in the sewers, and then, when the private drains are stopped up, to open the sewer and get out the deposit by means of buckets, and remove it in carts? Yes, am.—Have you seen any illness result from this practice? I cannot state a case, though I have no doubt of its highly injurious effects; but can decidedly speak to illness arising from the accumulations. The illness is just the same as from cesspools; a low depressing nervous fever, most like that which is described to be the form of the jungle-fever. In November or December last they were taking up the deposits from the sewers near Broken Wharf, in Upper Thames-street; the stench from it was quite sufficient to have produced any fever; it was not within my district, and I do not know what were the effects. Fortunately there was clear weather, and the wind blew towards the river.—Have you any doubt that the removal of such refuse, as well as the accumulation, must be attended with danger to life? Yes; if any person in a state of mental or bodily depression were exposed to such an influence it would produce low fever, it would be dangerous in proportion as it was stagnant.—In passing through the City, have you been assailed with smells from gully-holes? Only yesterday, in passing through the City, the smells from many of the gully-holes were very offensive; and several medical friends agree with me in attributing extremely prejudicial consequences as arising from this cause."—The Commission have no sewer at Broken Wharf; I do not know what particular sewer it refers to. The sewer in Thames-street has been occasionally obstructed by floating substances washed there by the river, and occasionally the head-water has not been sufficient to cleanse it.

Have you any doubt as to the accuracy of these statements?—I never for a moment doubt the truth of any statements made

Mr. R. Kelsey. by a respectable man ; and as to the matters of opinion, upon those I am not competent to form any judgment.

Dr. Wray, another medical officer of the West London Union, is asked, "Do the sewers often emit offensive effluvia? Very often, even in the large public streets. I was standing the other day at a snuff shop in Fleet-street, when the effluvia from the gully-hole of the sewer was so bad that it was scarcely endurable. The people in the shop could not remain there without shutting the door.—Is there no cleansing the sewers? Yes; there is much cleansing going on. For example; the other day the sewers were cleansed in Water-lane by taking off the top and removing the deposit by buckets, and carting it away. They have been putting a new sewer in Water-lane, Shoe-lane, Fetter-lane, and Chancery-lane, all in my district.—Effluvia, however, still escapes from the main sewers into the streets? Yes, it does; and that is perhaps as bad for the public as the other is to the poor. At the present moment there is a great deal of fever in the neighbourhood." He is then asked, "Does the state of filth, and the effluvia caused by defective sewerage, by cesspools or privies, and decomposing refuse kept in dust-bins, powerfully affect the health of the population?"—He says, "Yes, it does. It always occasions a state of depression that renders persons more liable to be acted upon by other poisons, even if it be not the actual cause of it. The line of habitations badly cleansed, and in this condition, almost formed the line of cholera cases. From some of these places, such as Plough-court, Fetter-lane; Plumtree-court, Shoe-lane; Robinhood-court, Shoe-lane; Water-lane, Fleet-street; Lombard-street, in Bouverie-street; Silver-street, also leading from Bouverie-street; Field-lane, Union-court, Plough-court, Holborn-hill, we have still constantly fever cases. All these places are distinguished by filth and want of drainage, and proper washing. Nine-tenths of the diseases come from these filthy places." Is that a correct statement?—I think it is rather overcharged. There are places as to which I can explain whether they are drained or not. Lombard-street, in Bouverie-street, has a drainage which is not very good; it was built by the person who built Serjeant's-inn. Union-court, Holborn, is in this situation, that the whole of the broad part is occupied by vaults, and there would be considerable difficulty in getting a sewer through it. Plough-court, part of Plumtree-court, and Robinhood-court, have old but shallow drainage; Water-lane has a new sewer throughout.

With respect to the district near St. Botolph's, Bishopsgate, you have been making some considerable improvements in the drainage there, and in Half Moon-street and that neighbourhood?—Yes, upon the representation of Mr. Porter; immediately he complained of it to Mr. Tagg, who is one of the Commissioners, and the thing was taken up directly.

How long ago was that?—Last year, when it was mentioned,

and the Commissioners took the first opportunity of driving a new sewer there; they commenced the work in November, 1842. Mr. R. Kelsey.

Have you yourself visited those places, and do you know their state?—Yes.

Have you for ten years past, from time to time, visited those districts, so as to be acquainted with them?—Yes, and I have taken plans of them all.

Are you not aware that those districts had been very much neglected, and that at present they are in a very bad state, and have been so for many years past?—They have; and I mentioned before the reason, that they wanted an outlet.

Do you know these places, Thompson's-court, Thompson's-rents, Baker's-court, Providence-place, and Campion's-buildings, where it is stated fever prevails nearly the whole year round, and that it also prevails very much in Blyth's-buildings, Lamb-alley, Dunnings-alley, Sweet-Apple-court, Montague-court, Artillery-lane, Rose-alley, and Catharine-wheel-alley; it is stated that, "These places, all of which are badly drained, and not regularly cleansed, are seldom without fever for any length of time." Have you any doubt that that is the fact?—It is not quite the fact. Baker's-court has a drainage into an ancient sewer, so has Thompson's-rents and Green-dragon-yard.

Is the drainage in Baker's-court good?—I cannot tell; it is a private drainage.

Then you do not take cognizance of that state of the drainage in Baker's-court?—Not in private drainage: the drains run through private houses.

What is the state of the sewer there?—The sewer is shallow, but it is large enough for me to pass through. The Commission have repaired and cleansed the whole line, and rebuilt part.

That sewer was amply sufficient for the drainage of those houses?—Yes; but it was only about seven feet deep.

There is not a drain down the court?—There is not a drain through the court, but only from the houses.

What state is the gully in?—I have no reason to believe that it is other than open. The Commissioners are gradually going on trapping the whole of them.

Are you cognizant that the people at the next door to it cannot open their windows on account of the stench that comes from it?

—I do not know that.

Do not you or your sub-inspector from time to time look at the state of those things?—No; unless circumstances lead us to them.

You have had no complaints?—No; if any complaint is made, it is remedied at once.

If you had received a complaint it would have been remedied?—Yes; if the parties would take the trouble to come to Guild-hall it would be remedied.

Mr. R. Kelsey.

Is not it your duty as inspector to go and inspect it?—There are above 50 miles of public street, above 1000 distinct places, and above 35 miles of sewer in the City: it is obviously impossible to know everything at all times respecting them.

Do you know Thompson's-rents?—Yes.

Is there any drainage there?—The same kind of drainage. The sewer passes under the privy.

Have you had occasion to inspect Thompson's-rents?—Only the cleansing of the sewer.

Do you know whether it is in a clean and decent state, or the contrary?—The inner court may not be in a clean and decent state, but it is a private place, and the Commission would be trespassers in going into it. They have nothing but the drainage, which has existed countless years before the houses were built, it having been one of the rills which fed the Walbrook. The Commissioners are now constructing a sewer along Half Moon-street, and they have provided branches for entering those points. These are in process of execution.

With respect to Blyth's-buildings, Lamb-alley, Dunning's-alley, Sweet-Apple-court, and so on, which are stated to be all very badly drained, and not regularly cleansed, and seldom without fever for any length of time; those are populous districts; what is the reason that no drainage has been made into those districts till last year?—There was not depth enough in the sewer in some places to drain them. In Lamb-alley you go four or five feet down from Sun-street.

What is the reason that you have not made any sewer into those populous places?—The Commission were not able to do it; it is only within the last few months that they have obtained permission to pass through some private property belonging to St. Bartholomew's Hospital, which enabled them to make this improvement.

The fact is that those populous districts are not drained?—Parts of them were imperfectly drained, and the men are now at work building sewers in them.

You have made a drain along Sun-street?—There is a sewer through Sun-street.

How long has that been made?—Forty or fifty years.

In Half Moon-street what has been done?—In Half Moon-street the Commission are now at work building a sewer. There was a short length of sewer at the east end.

You are aware that all that part is extremely filthy and dirty, and that the surface-water lodges in every direction about it?—I am quite aware of that, and I have been doing everything I could to carry the improvement into effect.

Are the draining and cleansing of that neighbourhood under the jurisdiction of the City?—They are.

You are aware that they are in a very bad state?—I am

aware of that. But the Commission are now labouring under a difficulty. They have been desirous of introducing the sweeping-machine, and they agreed to give 1400*l.* a-year more for having it done by the machine than they would have to pay for having it done by hand-labour. Gore, the contractor, offered to cleanse the whole City, by hand, for 3200*l.*, and to do it with Whitworth's machine for 1400*l.* more, which would amount to 4600*l.* From this has to be deducted 400*l.* for the collection of ashes from the houses (technically "Dusting"), reducing the total cost to 4200*l.* The Commission agreed to give the large sum of 1400*l.* more, hoping the machine would sweep the streets more effectually. The courts and alleys must, however, still be swept by hand. Messrs. Whitworth themselves offered to do the cleansing for 6500*l.* An offer was also made by Dodd to pay for the dusting 600*l.*, which would have reduced the whole cost to 5900*l.* They subsequently offered to do the work at Gore's price, undertaking to find a man who would cleanse the courts for the dust; but ultimately it was arranged that Gore should do the work, and they supply him with eight machines.

Mr. R. Kelsey.

Can you state the number of men employed in cleansing the surface?—I have learnt that 67 men are generally employed in that work, exclusive of the masters and foremen, and also of the men employed in collecting dust.

You have stated that there are 50 miles of streets, and it is stated that the carriage-ways amount to 354,250 square yards, and that the inaccessible courts and alleys amount to 150,900 square yards?—Yes, I believe that is correct.

Making a total of 505,150 square yards to be swept for the surface cleansing of the streets?—The main streets are cleansed every day; the others are cleansed twice a-week, or three times a-week; and all the courts and alleys ought to be cleansed twice a-week.

Are you certain that that is done?—No, I am not certain that it is. It is the inspector's duty to see to it; but I have facilitated Mr. Whitworth's views as much as possible, because I am desirous of seeing it better done than it ever has been.

What is the contract price for cleansing those?—4200*l.*, the party taking the dust from the houses.

Ought they to go once a-week to take away the dust?—They go when they are called.

Does your inspector go from time to time to see whether there are any complaints among the inhabitants upon that subject?—Yes; it is his business to do it. The inspector of that district is a very active and very intelligent officer. There is more difficulty in getting those people to be clean than you can conceive.

But it is the duty of the inspector to see that the contractor sweeps and cleanses those places?—Yes; but if the inspector stands over the men and sees a court cleansed out, within half an

Mr. R. Kelsey. hour after half a cartload of dirt will be brought out by the inhabitants, and put down in it.

If the inspector has not enforced the cleansing of it from month to month he has omitted to do his duty?—No question about it.

The question is that those places are seldom or never visited by the scavenger?—If the meanest inhabitant of the almshouses in Gingerbread-court were to come to Guildhall any day and make a complaint, it would be attended to.

How do you account for those places being in such a filthy condition at the present time?—I cannot account for it beyond the filthiness of the people.

The question is with reference to those places being unswept and apparently uncleaned from time to time, the surface draining being in the worst possible condition?—There may be a reason for the state of the surface. The Inspector of Pavements was perfectly cognizant of the Commissioners intending to make a sewer there, and it was not worth while to repair the pavement twice over.

Here is Catherine-Wheel-alley, and Widegate-alley, and other places in that neighbourhood. Are you aware of a great deal of defective drainage in those places?—Yes; and I have instructions from the Commissioners, as soon as I am able, to make a sewer in Catherine-Wheel-alley, and Widegate-alley, and Artillery-street. The two last have for years had some obscure private drainage.

And Rose-alley?—Rose-alley is partially drained, not by a public sewer, but there is a drain running under the whole of the houses at the west end.

You are aware that the sewerage and drainage are in a very defective condition?—I am aware of it. I have called the attention of the Commissioners to it. They have ordered me to build sewers in them; and I am to do the same with respect to Gravel-lane, Stoney-lane, and Duke's-place.

Are you aware that that being the poorest and most destitute portion of the district nothing has been done in the way of drainage?—I am aware of that.

Has not the surface-drainage also been neglected?—The surface-drainage has always been attended to.

You say that at present attention is paid to it, and it will be remedied?—It is ordered to be done.

You know these places yourself?—Yes.

You know that they are very miserable and dirty places?—Yes.

Do you know that fever is constantly prevalent in some of those places?—I do not know it as a fact, but I can quite believe that it would be so.

Have you in passing into them yourself perceived offensive smells from the privies and so on constantly coming out?—No,

I cannot smell, but I know it is bad, and I have been desirous of doing everything that I could for those poor neighbourhoods. I may mention one circumstance which I think will exonerate the Commissioners from any suspicion of having a feeling in favour of rich neighbourhoods,—that before I became their officer, and before they had a new and deep outlet into the Thames, the north of Cheapside was much better drained than anything south, because that was the worst and poorest neighbourhood, and they had turned their attention to that first.

You cleanse the drains at present by hand. Do not you think it would be possible to avoid cleansing them by hand by scouring them by water?—I am looking to that experiment with some anxiety; it is now being tried in the Tower Hamlets, and we shall then ascertain whether it will do.

You are at present in the habit of damming up heads of water, and using them to scour?—Yes, occasionally.

They would not only scour the main sewers, but also the collateral sewers?—The main sewers would not want cleansing; the current is such that they hardly ever collect any deposit, except where there is a little hollow, and that I am now curing. As a proof how little need be done in a main sewer, I may remark that that which crosses Smithfield was actually forgotten by the residents; and when I mentioned it to the Deputy, who had lived in Smithfield a large portion of his life, he told me that he knew nothing about it. It had been built about 70 years, and no one of the inhabitants ever knew it to be cleansed.

You make the following statement in your Report, page 49:—“There is a wide difference between that which is so fluid as fairly and honestly to flow through the gratings and that which has to be forced down by brooms or broom-handles; a practice interdicted, and, as I take it, notwithstanding the new light which is striving to blind us, very wisely interdicted by the Legislature.” Is that an objection to the flushing system?—Not an objection to the flushing system, but an objection to turning the whole filth of the streets into the sewers; for it has been recommended that all the filth of the streets should be washed down the gullies into the sewers, and so into the river.

Have you paid attention to the force of the water in carrying away substances in suspension, and the hydraulic principles on which the practice of flushing is founded?—I have read statements in books, which I dare say are perfectly correct; but I am exceedingly doubtful if you can get a stream of water in a sewer to sweep away angular sand. It cakes down when the sewer has been for some time not cleansed, though it has had a large run of water over it, and we are obliged to get pickaxes to divide it.

It has been stated that drains containing the sweepings from Macadamized roads nine inches deep have been swept by flushing?

Mr. R. Kelsey.

Mr. R. Kelsey. —I must say that I doubt it. If the stuff of Macadamized roads be clay, a large portion of it will go; it is only the harder parts, as the quartz, that would remain, all the detritus of the felspar will go away. It is, in fact, a clay, which can to some extent be held in suspension in water.

Then what do you fear being swept from the roads into the sewers?—The gravel and stones. I find bricks; I find even paving-stones in the sewers.

Is that a general thing?—It is to a much larger extent than would be supposed.

Supposing, upon experiment, it should be found that the flushing system is beneficial, you would have no objection to adopt it?—None at all. The Commissioners would be glad to adopt anything that is found beneficial.

Your sewers are made of the size for a man to go up. That is for the purpose of removing deposits which may take place. Supposing the flushing system should be found effectual, will it not enable you to make sewers of a smaller size than a man can get up, and at a cheaper rate?—No; they would still have to pass through the sewers occasionally to examine them; for example, to examine whether the sewer has been injured by any person breaking a drain into it. You must have it large enough for a person to pass through.

You do not contemplate that for the purpose of draining alleys or small streets it will be possible to have any drain less than a man can pass up?—I think they ought not to be less.

Then if other engineers and surveyors are of that opinion, you think they are wrong?—Either they are wrong, or I am wrong.

You might require the sewers so large that it would be necessary to have man-holes in order to go down and cleanse them?—A gully-shoot and a man-hole are in the City identical. My stench-traps are so large that we can occasionally take up the grating, and a man goes down, without opening the street, into the sewer.

What is the cost of making a junction from a house into the sewer?—The whole cost of the drain from the house to the sewer is 5s. 6d. per foot.

How much does that come to upon the average?—It depends upon the width of the street.

Do you consider that it is necessary to have the drain as large as 15 inches?—I should be very sorry, in any little property I possessed, to make anything less than that. My predecessor had a court of houses, and he built a drain 12 inches wide, and at one part it was nearly two feet six inches deep; at the upper end it was shallower; and it was placed immediately under the water-butts at the back of the houses, passing through the cesspools and the privies, and constructed so that, by fair usage, it ought to have

remained untouched for 50 years; but it was constantly obstructed by the carelessness and wantonness of the inhabitants. At one time I found actually a butter-firkin purposely stuck in the drain to stop it. That shows how requisite it is to have a large drain. Mr. R. Kelsey.

You do not think a nine-inch barrel-drain or a twelve-inch barrel-drain would be sufficient?——It would not be. I should not be satisfied with it myself.

You think they should not be less than 15 inches?——Yes. I mean outside the house. It is a very old regulation of the Commissioners.

And that rule applies equally to large houses and to small?——Yes; I should say more to a small house, because the drain is more likely to be ill used.

Then the expense of 5*l.* or 6*l.* for communication between the sewer and the house is the same in a small house as in a large?——It would be if the length was the same, but generally the length is much less. Many drains cost less than 2*l.*

You think that, upon consideration of the whole subject, it will not do to have them of nine inches, or any smaller diameter than fifteen inches?——Not in the street; not under the public way.

Are you not aware that the expense thrown upon the inhabitants of those poorer class of houses is one reason that prevents their communication with the drains?——I doubt it very much.

You do not think the expense is the objection?——I do not think that is the objection, except that some persons do not like to spend sixpence upon anything; but a man with proper feeling would never regard that expense.

You have never contemplated the communication between the sinks and those smaller sewers being made by vitrified pipes?——No. If there was an obstruction in such a pipe, the difficulty would be in cleansing it. If they were made larger they might succeed. They might be made 15 inches in diameter for cross drains under the street.

Have you had any suggestions for making them of that material?——None at all.

Do you think they would succeed?——They would succeed if they would come to a less price for the same size.

You think the small diameter of four or five inches would not be sufficient?——No; half a brick would stop it.

Supposing they were well supplied with water and had a proper inclination, you think they would not be sufficient?——No; because in poor houses you can never keep them free from coals, cinders, bottles, broken pots, and all kinds of hard rubbish.

Supposing there was a stench-trap at the top of them over the drain, do you think that would be sufficient?——Yes, it might; but the people would wrench away the grating directly. In former days, when it was considered illegal for night-soil to come into the sewers, the Commissioners always required a fine grate to be at

Mr. R. Kelsey. the head of the drain; but of late years, since the introduction of water-closets, they have not been rigid in that rule, and filth of every kind comes into the sewers.

You have no power of compelling the inhabitants of houses adjacent to sewers to communicate with the sewers?—None.

Do you think that some such power properly guarded would be advantageous for the health of the district?—I have thought a great deal upon that subject, and it appears to me if landlords were obliged to have drains carried from the sewer to the front of the houses it would be an exceedingly good thing, but that it would be very obnoxious for public officers to break into a private house and to make drains for them. In cases where I have been asked my opinion, I have advised the landlord to build the drain outside the house and the lessee those inside it. Both have been pleased with the suggestion, and have acted upon it.

Would not it be desirable to have the power of compelling it to be done?—It would be desirable.

Do not you think that there should be some regulation that cesspools should not be sunk below the level of the common-sewer?—I do not think that it would be desirable.

It was an old rule that the night-soil should not be discharged into the sewers, was it not?—Yes.

It is now, to a certain extent, acted upon, except that the water-closets discharge themselves into the sewers?—I believe they all do that.

Do the privies go into the sewers?—Yes; the drain from the privy flows into the sewers.

Do not you consider it desirable that every privy should do it?—Yes.

That there should be drains running from the privies into the cesspools?—Yes; but then you would want a catch-pit at the head of the drain to prevent other matter going in.

But it would be desirable that the contents of the drains should go into the sewer?—Yes.

To what extent do those materials accumulate in the small drains?—To a large extent.

Pottery-ware and bottles?—Yes, and coals and refuse; in fact, all the refuse of the house is thrown down the privy; that is the commonest thing that can be.

Is that where there is an ash-pit provided?—Yes, it always is so among poor people, and even among the servants of the rich.

Do you not think it would be practicable to use a grating that would prevent all that?—You might have a grating at the head of the drain to prevent it running into the sewer; but you could not prevent the head of the drain being filled up by those people. It is not the father and mother merely, but all the children, who throw everything down the privies as a matter of course.

Just now you mentioned in your evidence that a certain sum per annum for the last 10 years had been expended; and you said that some of the cost was for searching out the sewers; do you mean by that, the discovery of sewers not previously known?—

Yes. In searching out sewers that were not previously known, or had been made before the last 70 or 80 years, previous to which private individuals made them, and the Commissioners had no control over them. They were frequently carried under property in various ways; and the plans made by one of their officers many years ago not having been preserved, or having been accidentally lost, possibly at the time when a fire at Guildhall destroyed some of their books, their existence was not known.

As you are now carrying out a minute inquiry, do you consider that there are sewers unknown in that district?—I should apprehend but very few, if any.

Then you consider that there may be some?—It is just possible. I am speaking of a thing which I do not know, but it may happen.

In the city of London, the paving and so forth is under the same authority as the sewage?—Yes.

Do you find a great convenience in that, in being able to consult with each other as to breaking up the streets?—Yes, it is the same Commissioner and the same officer, and therefore my left hand knows what my right hand means to do.

You find some advantage in that?—Yes, some advantage, but not very great; it has long been so with the London Commissioners; for, although at one time they sit as Commissioners of Sewers, and at another time they sit as Commissioners of Pavements, it is the same body.

What is the duty of the inspector under you? You stated that he went to certain places to receive complaints made to him?—There is a book kept at Guildhall, in which all complaints are entered; and the three inspectors of pavements and the inspector of sewers are required to be there every day, as near as they can, between twelve and one o'clock to read the complaints, and to remedy them; and either my clerk or myself is there nearly every day.

Is it any part of the duty of the inspector to inspect each of the districts without complaint being made?—Yes, it is his duty to be every day in his district; works are constantly going on; and in the natural execution of his duty he can scarcely avoid passing through it.

Does he keep any record of his labours?—Yes, each inspector has about 17 miles of public way, and above 300 distinct places to look to; of course that cannot be done every day; but there are places of which, by glancing at, he may ascertain the state pretty nearly; but it is his duty to pass through them as often as he can.

Mr. R. Kelsey.

And to report to you if he finds any nuisances?—Yes; where there are any of small importance he remedies them at once. There is not simply the inspector, but there are two Commissioners who reside in each of the wards of the city; they are always accessible; they are elected every St. Thomas's-day, and therefore they are obliged to answer to their constituents.

Has the inspector the execution of the sewers and the things that are in progress, or is he the inspector of paving only?—There are three inspectors for the paving and cleansing; there is one inspector who has to superintend the cleansing and reparation of the sewers; the construction of new sewers and formation of new pavements is under myself, and the clerks of the works employed from time to time.

You mentioned that you were trapping all the gullies at present as you get opportunity?—Yes; and when there are complaints of a very grievous character they are done immediately.

Do you mean to trap all throughout the whole of the district?—Yes; the Commissioners have put down between ten and eleven hundred already.

You spoke to another circumstance, of having stench-traps; what is the precise arrangement of stench-traps in your district?—I have put a drawing in of the kind of thing which is used.

What is the object of it?—To prevent the rush of air through the sewer-grate being felt in the houses.

Is that rush exceedingly great?—In some cases it is. They have very seldom failed when they have been introduced, and when they have failed it has been from a little tightness in the fitting. But there is one circumstance that annoys the Commissioners and the inspector very sorely; there is a class of men who make a living of getting into the sewers to pick up anything valuable that falls into them, and when they pass by one of those traps they feel a little want of ventilation, and they put a brick or stick to keep it up, and then we have a complaint that the air-flap does not answer.

Is not your police sufficient to prevent that?—No; they go down into the river by stealth; we cannot prevent it: boys, as a piece of fun, go in. I have thought of putting a grating at the mouth of the sewer; but then I am afraid of stopping something that ought to go out.

Have you a flap at the outlets?—No; except in a few instances. The sewers are open to the river.

Did you find any practical objection from the bad state of the atmosphere when the men are sent down to examine or to clear out the sewers?—No; some time before this system was introduced of ventilating them, we had a few accidents in consequence of inflammable gas being in them; some men met with serious injuries.

Are you sure that it was inflammable?—Yes; it caught fire, and burnt the men very seriously.

Under ordinary circumstances, what is the state of the atmosphere which escapes out of the ventilating openings?—Sometimes the gas-pipes are faulty, and the gas will escape from the mains into the sewer; and then a person passing by who is able to smell better than I can, immediately says there is gas in the sewer, and sometimes the gas-man goes there and burns it off.

Did you ever hear any complaint of escapes from those ventilating apertures?—We have had occasionally: but very little.

Then those stench-traps are to exclude the air from the private houses?—Yes; to prevent the stench rising close to persons' windows.

Do you think it would be desirable for the Commissioners to have the power in certain cases to pass through private property for the purpose of making sewers?—I think it would; of course making good any damage they did. And with respect to any private drains, if A should have a house behind B, and could not get other drainage but by passing through B's house, he should have power so to do, the Commissioners giving him compensation. I have had a very troublesome case of the kind lately.

You mentioned that sometimes floating substances were carried up the sewers from the river; do you find that frequently the cause of accident or obstruction?—Not very often; it is only occasional.

You would not put it as a very important point to attend to?—It would be in a low district; but the City district is so high that we have generally water enough to clear it.

You would not allow the low district to be washed by the river by any water floating in?—No; I would keep all floating bodies out of the sewer.

Are there many cesspools unconnected with the drains in the City?—Yes; in all the districts where there are no common sewers, and even where there are.

Are those cesspools under any regulation as to cleansing?—No.

Do you know anything of the state of the sewage under the Old Bailey prison?—There is a main sewer of six feet diameter there.

Are you aware that there are cesspools there which have not been cleaned out for 10 or 20 years?—No; that is not the fact; it is within the last 8 or 10 years. The Commissioners have rebuilt a portion of the sewer, for it had been built of very bad material; and under the superintendence of the inspector, drains were made from the cesspools of Newgate into the sewers.

Have you ever observed the quantities of water flowing in those large sewers?—The general run in most of the sewers is from a foot, perhaps, to 18 inches or 2 feet deep. The water-mark in the sewer in Moorfields is as high as my shoulder.

Mr. R. Kelsey. Do you know whether the water ever fills it?——I do not know it of my own knowledge, but I have been so informed. I know that it does in the Fleet-ditch, which is very much larger. The double sewers in Farringdon-street are 14 feet high, and 6 feet 6 inches wide.

Is there any injury to the sewer from that cause?——No, there is not. I happen to know it from the circumstance of our men being employed in cleansing and repairing those sewers, and it being so high they were obliged to have some little scaffolding to point the arch of the sewer, and put it to rights, when the ladder was snapped off short, and all the scaffolding swept into the river by a flood which filled the sewers.

You have acted as a surveyor of buildings, have you not?——Yes.

Do you think the system of payment by fees is objectionable?——I have given evidence before a Committee of the House upon the subject, and therefore I can feel no difficulty in repeating my impression, though I hope you will not take it as affecting the district surveyors of the metropolis. My feeling is that it would be exceedingly desirable that there should be a central office; say, for instance, for the whole City at Guildhall, or at some other point; that notice should be given at that place of a party intending to build a house, or to alter or add to it; that when he sent that notice, he should pay a certain amount; and out of that the district surveyor should be paid the whole, or whatever portion may be thought fit. I have acted as a district surveyor, and, therefore, knowing the insults I have met with, I feel the matter very strongly, and think it would be very desirable to make that change; that it would increase the influence and respectability of the district surveyor, and prevent a good deal of ill feeling.

APPENDIX No 1.

CITY OF LONDON.

Expended in the construction of new Sewers.

1833	.	.	.	.	.	.	£10,564
1834	.	.	.	.	.	.	13,699
1835	.	.	.	.	.	.	10,590
1836	.	.	.	.	.	.	13,062
1837	.	.	.	.	.	.	9,482
1838	.	.	.	.	.	.	11,653
1839	.	.	.	.	.	.	17,058
1840	.	.	.	.	.	.	15,179
1841	.	.	.	.	.	.	12,400
1842	.	.	.	.	.	.	7,822

£121,509

APPENDIX No. 2.

June 26, 1834.

MEMORANDUM laid before the Court on Tuesday, as to the depth of Drainage.—A house cannot be called effectually drained unless the water is taken away from the floor of its lowest story.

Take the least height which a basement story ought to be.	Ft.	in.
Thickness of a timber flooring on sleepers	0	9
Covering of the drain, say brick flat	0	2½
Height of drain inside	0	9
Current of drain inside the premises, say 1 inch to 10 feet for a house 50 feet deep	0	5
Current outside the house, <i>i. e.</i> in the street.	0	3
Height of cross-drain above the bottom of main-drain, at least	0	6
Gives	9	10½

This would give 10 feet, at the least, depth from the surface of the street to the bottom of a main drain (of 18 inches diameter), and this may be fairly assumed as the least depth at which a private house of the most ordinary description can be effectually drained ; but this considers it only as for the drainage of one house.

When a series of houses, situate in a public way, inhabited by some who will use, and some who will not use, a drain fairly, is to be drained, the question has to be looked at differently.

For a retail shop, in which the basement story is often used as a warehouse, it cannot be unreasonable to say that the story shall not be less in height than	Ft.	In.
Flooring	0	9
Covering of drain	0	2½
Height of drain	1	3
Current inside	0	5
Ditto outside	0	3
Height above bottom of common sewer	1	6
Gives	12	10½

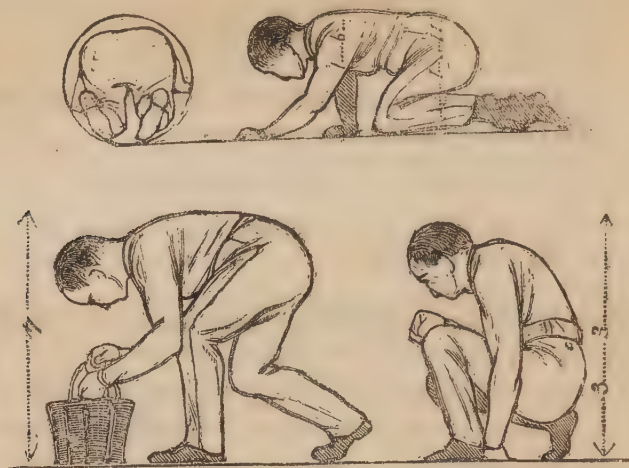
As it may be said that a story of less height might do as a wareroom, and in order to keep the calculation as low as it fairly can be kept, I would assume that the bottom of a common sewer ought not in any part to be less than 12 feet beneath the surface of the street.

As to the size of Drains or Sewers.

For the ordinary purposes of one house, an 18-inch main drain, receiving collateral 9-inch drains, may, with fair usage, last many years without cleansing ; but, when it has to be cleansed, the trouble and the cost of digging pits from the surface, and raking out the filth, will be considerable.

Mr. H. Kelsey.

But for the use of a line of houses in a public street, wherein some one or other will treat the drains unfairly, it may be laid down as a first principle, that no common sewer should be so small that an ordinary sized man could not get in to cleanse it; for if it were so small, it would not only soon become choked up, but opening the surface to cleanse it would stop, or more or less impede, the traffic of the street.



Taking a man of ordinary size, it will be found that a height of 1 foot 11 inches will just allow him to squeeze through on hands and knees, and 3 feet 3 inches will admit him crouching, and 4 feet stooping. To these must be added 2 or 3 inches to allow of the raising of the body when moving forward; and there should be some additional allowance for indurated soil in the bottom of the sewer.

Taking these data, one can scarcely allow less than from 2 feet 4 inches to 2 feet 6 inches for a man to crawl through, and 3 feet 6 inches for a man to crouch through, and 4 feet 4 inches to 4 feet 6 inches for a man to stoop through; and as few men are less than 21 inches across the shoulders, it will not be unreasonable to say that 2 feet is the least width in which a man can work effectually, although he may pass sidewise through 14 inches.

Applying these to the question of what is the best sized sewer that ought to be built in any street, one is compelled to admit that it ought not to be less than 30 inches by 24 inches; and its depth not less than 12 feet in its shallowest part.

The thickness of the brickwork cannot be less than 9 inches, nor would it be prudent to leave fewer than two tiers of strutting and planking in the ground.

The cost of such a sewer would probably be about 9s. 9d. a-foot, being somewhat less than half the cost of a sewer 4 feet 6 inches high and 2 feet 6 inches wide.

But this assumes that the work is done under the most favourable circumstances, and at the present low prices; and the calculation, of course, does not include gullies, man-holes, &c., nor securing the houses of a narrow street.

If the Commissioners were to say, We will charge the locality with half the cost of this, the smallest size common sewer which ought in any case to be made, and take the remainder out of the rates, they would act with

exceeding liberality, and really charge the houses with no more than the common cost of a 15-inch drain.” Mr. R. Kelsey.

Mem.—The term common sewer (as for more than one house) is used in contradistinction from public sewer (as unfit for more extended purposes); and taking the limited height of 20 inches from the bottom of a public sewer to the bottom of a drain, as a fair and reasonable allowance for the accumulation of soil in such sewer, before the private drains can be obstructed, and the sewer said to be foul: by adding 2 feet 6 inches to that, we shall find that 4 feet 2 inches is the least height which it is advisable to give a *public sewer*, but 4 feet 6 inches is better, as allowing freer space for cleansing.

W. E. HICKSON, Esq., examined.

W. E. Hickson,
Esq.

You were one of the Commissioners of Inquiry into the State of the Hand-loom Weavers?—Mr. Senior, Mr. Samuel Jones Loyd, Mr. Leslie, and myself, were the members of that Board.

In your own special report on the state of the weavers in the manufacturing districts, presented to the House of Commons August 11, 1840, there are some observations upon the defective habitations of the working classes. Has your attention been since directed to the same subject, and can you supply any additional evidence relating to the objects of the present Commission?—My attention has been continually called to various points connected with the present inquiry, from the circumstance that a considerable portion of my property is invested in houses, and I shall have great pleasure in stating to the Commission the conclusions I have drawn from my own experience of what are the chief obstacles to the improvement of public health in towns. Those obstacles I find in the existing defective laws relating to drainage, in the want of simplicity and efficiency in the local machinery for carrying those laws into effect, in the regulations of the Water Companies relating to supplies of water, and in the present mode of assessing houses to the window-tax, a mode of assessment which operates as a direct encouragement to bad ventilation.

Will you state first any facts which have come within your own knowledge relative to the obstacles which may exist to improved drainage?—I will just mention the difficulties I experienced in a recent instance in getting a new sewer made in the City. I had taken a plot of ground for a building investment, extending from No. 67, Fleet-street, 178 feet down Water-lane. Although so near the Thames, there was no sewer in the street, and before I could build up a new row of houses it was necessary to have a sewer made. I directed my architect, therefore, to apply to the City Commissioners of Sewers, and to state the obvious fact, that if the Commissioners contemplated making a sewer at any time in that neighbourhood, it was exceedingly desirable that it should be

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made now, before the new houses were built. The answer to the application was, that a sewer in Water-lane could not be made unless the inhabitants would contribute 210*l.* toward the expense, about one-third the total cost. This seemed almost equivalent to a refusal of the application; for, as no one was about to build but myself, no other person was equally anxious on the subject with myself, and it was very doubtful whether the money could be obtained. We endeavoured, however, to obtain it; we applied to every inhabitant, and took great pains to find out the original leaseholders, freeholders, and others interested in the adjoining property. But, with one solitary exception, not a soul would contribute a shilling; and I must say the reasons assigned were in many cases good and sufficient ones, and reasons which show the folly of expecting to raise large sums for sewers in this manner, or the impolicy of enforcing such contributions if it were proposed to do so. One man was only a yearly tenant, and refused because he had no permanent interest in the improvement of the property; another was a leaseholder, but his lease was just about to expire; another was only executor to an estate under which the property was held, the freeholder being dead; another was one of several trustees, all of whom must be consulted, and some were absent in the country; in other instances the freeholder was abroad, and the agent could do nothing without his authority. Finding this to be the state of the case, I forwarded another application to the Commissioners of Sewers, in which I offered 100*l.* towards the expense of making a new sewer, although my proper share of the contribution was but 35*l.*, and urged the Commissioners to accept this sum in lieu of the 210*l.*, which could not be collected. To support such an application, it was intimated to me that it would be necessary to get petitions and memorials signed by the most influential inhabitants of the ward; and as there were 90 Commissioners of Sewers, some of whom might be crotchety on the subject, to make by private exertions as many friends amongst them as possible. We had therefore to canvass churchwardens, overseers, and others; and besides all the letters and attendances of the gentleman I employed, I was obliged myself personally to attend one ward meeting, two meetings of the Commissioners, and to see Sir James Duke, on the bench at the Old Bailey, to get his signature to our memorial, before the final determination of the Commissioners could be obtained.

Was it at last favourable to the application?—Yes; I was informed that, upon payment of the 100*l.* to their clerk, Mr. Daw, a contract for the new sewer should be immediately advertised; but in the meantime the best season for building had passed away. The negotiation for a new sewer occupied three months, and, from first to last, it was six months before the sewer was completed. We had, therefore, to commence building late in

the year, at every disadvantage; and it was Christmas before the roof of the corner house in Fleet-street was covered in.

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In what year was this negotiation with the City Commissioners? —In the spring of the year 1842. My contribution of 100*l.* was paid into the Chamberlain's Office on the 18th of June; the sewer was completed the beginning of October.

What is the inference you would wish the Commissioners to draw from the facts you have described?—Simply that if my object had been that of a small builder, to erect cheap fourth-rate houses for the poor, it would have been quite impossible to have connected them with a good drainage, from the serious loss arising from the delay, trouble, and expense attendant upon the present system; I must, in that case, have contented myself with the old cesspools.

What is the remedy you would suggest?—The remedy would be, first to simplify the local machinery for the administration of the laws relating to sewers, by giving the direction of them to a few competent surveyors and engineers, engaged for the public, instead of a large and miscellaneous body of gentlemen and tradesmen, having no practical acquaintance with the subject, and governed more or less by the conflicting interests of different wards or different parishes. But the whole of the laws relating to sewers require revision; they are now imperfect and contradictory.

Can you give an instance, from your own knowledge, of any one of the imperfections to which you allude?—The law requires, and very properly, that no house shall be built with drains running across it from the adjoining houses; yet the Commissioners have not power to divert an old drain without the consent of the occupier, and this I discovered to my great regret when building the house in Fleet-street to which I have referred. The adjoining house, No. 66, should drain into the Fleet-street sewer, instead of which the drain runs under the basement floor of the new house I have built (No. 67) into Water-lane.

Does it not occur to you that, under any system, however much improved might be the administration, the cost of the first outlay in the construction of a new sewer, and the necessity of finding resources for it, must always be a serious difficulty?—On the contrary, I am satisfied there need be none whatever. There are two modes of meeting the expense of the first outlay:—the one, by authorizing loans from Government or private capitalists on the security of the sewers-rate; the other, by offering to exempt from the sewers-rate for a certain number of years those who might be willing to construct sewers at their own expense under the direction of competent surveyors or engineers. For example, if I had been the proprietor of the whole of the houses in Water-lane, I should have been exceedingly happy to have made the sewer entirely at my own expense, in the best possible manner, if

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in return the property could have been exempted from the payment of sewers-rate for 30 years; and I do not know a better investment for money.

Will you explain yourself more fully?—The sewers-rate in the City is practically 5*d.* in the pound, which, on 10 second-rate houses, occupying, on opposite sides of the same street, a frontage of 100 feet, and rated at only 50*l.* per annum each, would produce 10*l.* 8*s.* 4*d.* per annum; but the cost of a sewer of this length would not exceed 100*l.*, or 5*l.* per annum. Thus, by making my own sewer I should realize a large profit, if exempted from rates. In streets of great importance, such as Fleet-street, where the houses occupying a similar frontage are rated, upon an average, at 100*l.* per annum each, a rate of 5*d.* is a charge of 25 per cent. per annum upon the original cost of the sewer.

But in fourth-rate houses, or in tenements occupied by the poor, probably the same rate of 5*d.* would not be remunerative?—Houses of that description in the City are chiefly situated in courts and alleys, where at present there are no sewers, and where, if made, 18-inch drains, costing only 4*s.* 6*d.* per foot, would suffice, according to the statement of Mr. Roe, engineer for the Finsbury division. I am the owner of a house in a court at the back of the Mansion House, in which there is no sewer.

Are you correct in asserting that the sewers-rate in the City is 5*d.* Is it not 4*d.*?—It is 4*d.* nominally, but practically 5*d.*, because it is customary to transfer a large sum from the consolidated rate fund to the sewers-rate fund, both funds being under the same management. In the year 1841, 5,000*l.* were so transferred.

That is to say, the public paid, in the year 1841, for the sewers, over and above the amount of the sewers-rate, the sum of 5,000*l.* collected in the name of the consolidated rate?—Exactly so. The City accounts connected with the local rates are so mixed up together that no rate-payer can correctly ascertain the full amount of his contribution for any one object separately. The consolidated rate for paving, watering, and cleansing, and the sewers-rate, must be regarded as the same; and I find from a Parliamentary return (No. 467, 1842), that the total sum received under these heads, in the City, for the year ending September 29, 1841, was 64,697*l.* 17*s.* 3*d.*, out of which the expenses of management amounted to 5,507*l.* 10*s.* 1*d.*

You are of opinion that the expenditure of the City Commissioners cannot be adduced as an instance of economical administration?—Certainly not. But, to confine myself to the supposed difficulty of raising the money for the first outlay in the construction of sewers:—Companies might be formed in a week for draining effectively every part of London now without sewers, if authorized to collect a sewers-rate of 4*d.* in the pound for a fixed

period of 30 or 40 years. The question is one merely of figures. We know the cost, in ordinary circumstances, of constructing sewers, per foot, and we could ascertain from the parish books what a rate of 4*d.* in the pound would produce for any one street requiring to be drained, and the profits of the speculation would therefore be capable of mathematical demonstration.

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Can you inform the Board what a rate of 4*d.* in the pound would produce upon the whole rental of the metropolis?—About 120,000*l.* per annum, a sum sufficient to pay interest at 6 per cent. for a loan of 2,000,000*l.*, should it be necessary to raise such an amount for the drainage of the metropolis. The rental of the metropolis, as assessed to the police-rate, is 8,779,799*l.*; but this includes the suburban districts, and would realize more than the sum I have named.

Are you not aware that in certain cases of drainage the cost of the works to be executed must necessarily be disproportionate to the resources of the immediate neighbourhood?—Undoubtedly there are such cases; and, on this account, whatever districts might be intrusted to individuals or local bodies, the drainage of the metropolis cannot be perfected without a considerable expenditure on the part of a Board of Public Works, which should have the supervision of the whole; for instance, the improvements required for the better drainage of the lower parts of Westminster, and especially in the neighbourhood of the King's Scholars' Pond sewer, appear of too expensive a character to be undertaken by the Westminster Commissioners.

Will you explain the nature of the improvements you consider to be required in that locality?—If the Board will have the goodness to look at any map of London, they will see that the King's Scholars' Pond sewer is a large open sewer running at the back of a long line of houses in Vauxhall Bridge-road. Six of the houses in that line, forming what is called Trellick-place, unfortunately belong to me; I say unfortunately, because, owing to the nuisance of the sewer, the property is quite unimprovable. The sewer is exactly under the bed-room windows of these houses, and the stench from it in summer, at high water, when the contents of the sewer cannot escape into the Thames, and when a hot sun is playing upon their exposed surface, is necessarily great.

Have you applied to the Westminster Commissioners to cover in the sewer?—I have done so, but Mr. Donaldson tells me that although the object is a desirable one, the expense of covering in the sewer, owing to its great width, would amount to 4*l.* per foot, and he does not think the Commissioners could entertain such a proposition merely to benefit the occupants of houses along that line. Lower down the road, therefore, Mr. Cubitt intends to cover in the sewer at his own expense.

Do your tenants complain of the sewer as a nuisance?—They

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have repeatedly complained not only of it as a nuisance, but of serious illness occasioned by the stench arising from it. But were it not for the sewer, I could get a better class of tenants for these houses than their present occupants; as it is, I am obliged to let the houses to poor families, who depend upon lodgers for the payment of their rent, and these lodgers are continually leaving from illness. Only ten days ago one of my tenants said to me, "Sir, it is impossible to let my best rooms, every person who lives in them is taken ill."

May not this arise, not from the sewer, but from the defective state of the drains belonging to the houses?—It arises from both causes; but I am much concerned to find that the drainage cannot be improved without a reconstruction and a diversion of the whole line of sewers in that district. These houses do not drain into the King's Scholars' Pond sewer, which is so close to them, but into a private sewer on the opposite side of the Vauxhall-bridge Road, with which they communicate by 12-inch drains. But as the bottom of that sewer is at the shallow depth of only six feet ten inches from the pavement, it is impossible in crossing the road to get an adequate fall. The coal-cellars, therefore, under the houses of Trellick-place, although only four feet six inches deep, become practically offensive cesspools, into which the water from the neighbouring drains and the King's Scholars' Pond sewer percolates through the brickwork. I should add, however, that Mr. Doull, the surveyor of the Westminster Commissioners, says that as the King's Scholars' Pond sewer is lined with brick-work, three bricks thick, it is impossible that the contents of the sewer can find their way through; but other surveyors tell me that water will find its way through any thickness of brick-work not lined with cement, and this would appear to be the case, as the water in my coal-cellars rises the highest at high tides.

What remedy would you propose for the defective drainage you have described?—I think the King's Scholars' Pond sewer should be covered in and diverted from its present course. It might run down the middle of the Vauxhall-bridge Road, instead of, as at present, close to the back rooms of a long line of houses. I trust this Commission will not separate without recommending a public grant for immediately covering in every open sewer of the metropolis. This is not a solitary case; in the neighbourhood of Bethnal-green there are many open ditches which serve as sewers, the exhalations from which affect the surrounding houses with typhus fever. Whatever may be left undone, such nuisances should not be suffered to exist an hour.

Is not the level of the Vauxhall-bridge Road, and chiefly that of the lower parts of Westminster, so little above high-water that sewers could not be sunk to a greater depth than at present to give proper drainage to the basement floors?—From the con-

versations I have had with civil engineers on the subject, I think that there are practically no difficulties on this head which could not be overcome; but it might, perhaps, be necessary to assist the discharge of the sewers at high-water by a tide-mill, or a steam-engine, as in the Fens of Lincolnshire. Not, however, being a civil engineer, I cannot speak to this question. I only know that the drainage in the neighbourhood of this portion of my property is in a defective state, and that I would most cautiously avoid it for my own residence. When drains cannot be made at a depth of four feet six inches, the foundations of the houses must often stand in a soil saturated with moisture, as in my case,—and it is then impossible to prevent damp rising in the walls. But I have been surprised at the little attention which has been paid to this subject, even in the most fashionable parts of the same district. A large house in Ecclestone-street, at present occupied by Mr. Grote, was built without any outlet for the drains. It had become nearly uninhabitable from this cause before the defect was discovered.

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What evidence are you enabled to give the Board from your own personal knowledge upon the supply of water, as affecting the healthfulness of habitations in the metropolis?—I wish to add my testimony to that of every practical man who is acquainted with the poorer class of habitations, that a greater blessing could scarcely be conferred by Government upon the working classes of London, or one more essential to health and comfort, than that of a cheap and abundant supply of water, and that the present mode of supply is about the most expensive and inefficient that can be devised.

Can you support that opinion by any facts that have passed under your observation?—I will state the nature of the supply about Stepney, from the East London Water-works. The district is a very poor one, and owing to what is termed by the Directors of the Company “the waste of water” in that neighbourhood, but which might be perhaps more correctly described as the disposition of the poor to use more water than they can afford to pay for, the water is supplied at such a low pressure that it will not reach a cistern on the first floor of a fourth-rate house. This fact, or perhaps my ignorance of it, together with the Company’s regulation that no two tenements should be supplied from one cistern, has very recently caused me to incur a loss of nearly 30%.

Will you state the particulars?—I had given directions for fitting up two tenements in Ashley-place, Stepney, as shops and stables. Over each of the shops was a small bed-room and water-closet, but when they were finished we discovered, first, that although the cistern for these closets was but nine feet from the ground, the Company would not supply water at that height. Next, that as there were two tenements, we must provide two cisterns, instead

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of the one large slate cistern which we had made. The consequence of these regulations was, that we had also to provide tanks on the ground-floor, and then pumps to pump up the water to the first floor, in order that the water-closets which we had placed there might be cleansed. This was an extra cost upon two tenements (let at only 12*l.* per annum each) of 27*l.* 1*s.* 6*d.*, in addition to the annual charge for water, which is 32*s.*

That expense would, of course, not have been incurred if you had been aware of the regulations of the Company before you commenced building?—It would not so, but such regulations would still have involved a serious unnecessary cost; and I submit that on the public at large they operate most mischievously. There is now no adequate protection against fire, and public ornamental fountains might be constructed in every street for the expense incurred by builders of providing separate cisterns or water-butts, with their apparatus of pipes and ball-cocks for every separate tenement of a crowded court.

In the City water is supplied at a greater height than that you have mentioned?—At a greater height, but not high enough. In the case of the house in Fleet-street, which I have before mentioned, a first-class building, erected at an expense of between 2000*l.* and 3000*l.*, I was anxious that the water should be laid on to every floor, but we found this impossible; the Company supply it to the second floor only, and we are obliged to raise it to the water-closet on the third floor by pumps. It appears, however, to me, that with the inexhaustible resources of water at our command, and the great mechanical powers we now possess, there is no adequate reason that water should not be supplied to the top of every house in London, excepting perhaps a few built on the summit of Hampstead or Highgate-hills.

In what respect do you consider that the present mode of assessing houses to the window-tax is unfavourable to the healthfulness of habitations?—By operating as a premium upon defective construction. The legislature now says to the builder, plan your houses with as few openings as possible, let every house be ill ventilated by shutting out the light and air, and as a reward for your ingenuity you shall be subject to a less amount of taxation than your neighbours. The Board is, of course, aware that windows are now charged by a scale, the tax increasing at an average rate of about 8*s.* 3*d.* for every window, whether large or small. Hence the number of windows in a house becomes to builders of second and third-class houses a very serious consideration. Supposing a house to contain 12 rooms, if, to make these rooms cheerful and pleasant I have put two windows in each room, and thereby ensured a current of air passing from front to back, the window-tax for that house amounts to 7*l.* 5*s.* 9*d.*; but if I have put but one window to each room, the window-tax is but 2*l.* 4*s.* 9*d.*,

showing a difference of 5*l.* 1*s.* per annum; and I need scarcely say that a difference of only 10*s.* per annum is quite enough to influence builders of cheap houses in trying to save such a sum. But the same considerations affect the building of even first-class houses. I have been offered a rent of 21*l.* per annum for a house unbuilt, on condition that the plan should be altered so as to reduce the amount of the window-tax, for which the house would otherwise be liable. The consequence is, that in the majority of new houses one large window, of the largest size allowed, is made to serve the purpose of two windows; and privies, closets, passages, cellars, roofs, the very places where mephitic vapours are most apt to lodge, are now left almost entirely without ventilation. An opening only a foot square, even if intended merely to admit the air, and not glazed against the weather, makes the house liable for an additional 8*s.* 3*d.* per annum. I spoke but lately to a man in humble circumstances who had put in his privy a single pane of glass; it was discovered by the assessor, and rather than pay the tax (the money being an object) the pane of glass was removed, and the opening bricked up.

What has been the operation of the 4th and 5th William IV. cap. 54, by which all occupiers of houses, if duly assessed to the window-tax in 1835, were permitted to open as many windows as they pleased without additional charge?—The immediate effect was that everybody began improving the comfort and healthfulness of their houses by letting in more light and air, but the result has been that all who did so have found themselves caught as in a trap. A quibble was raised by the lawyers as to the meaning of the words “duly assessed,” and upon one ground or another they proved that nobody was duly assessed in 1835. Those persons, therefore, who could not afford to pay the tax for their new windows, have stopped them up again, and the loudest complaints prevail throughout the country of what is termed breach of faith on the part of Government. A near relative of mine was surcharged for 15 additional windows, on the plea that he was not duly assessed in 1835, because there were then in his house windows stopped up with lath and plaster which ought to have been stopped up with brick. He, however, escaped, fortunately being able to produce evidence to show that the windows referred to had been stopped up in that manner for 50 years,—in fact long prior to the 38th of George III.

Is your objection to the tax itself, or merely to the mode of assessment?—I do not expect in the present state of the revenue to see the window-tax repealed, but the revenue gains nothing by the present mode of assessment, while the public sustain a most serious injury. I would submit that all new houses should be assessed upon the principle that every house built requires for light and air a certain number of openings in proportion to its cubic

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contents, and these openings should be paid for whether they exist or not. This would at once remove every temptation to defective construction; and I think that, after a house had been once assessed, the proprietor should be at liberty to make as many additional openings as he pleased, in fact, to turn the whole of the walls into glass if he thought proper. I most sincerely hope that the serious and earnest attention of the Commission will be given to this part of their inquiry. A great practical improvement can be effected without any loss to the revenue, and by a few very simple clauses. The majority of houses of the second and third class will never be so constructed as to be healthful habitations while assessed to the window-tax, as at present.

As cottage tenements are exempted from the window-tax, is it not necessarily inoperative as far as the habitations of the poor are concerned?—Houses having less than eight windows are exempt; but the window-tax, I must submit, is not therefore inoperative as it regards the working classes of towns. In London the poor do not live in cottages, but several families occupy lodgings in the same house, and that, perhaps, a house built with the maximum of untaxed windows allowed by the law. One more window would possibly let a little sunshine into a sick room; but the landlord says “No, the house would then have eight windows, and I should be liable to a tax of 16s. 6d. per annum.” If the Commissioners would examine personally the houses in which the poor live in the close courts and alleys of the metropolis, they would be surprised at the number of dark staircases and filthy holes which, although on upper floors, are quite as ill ventilated and unfavourable to health as the cellars of Liverpool. And the permanent cause of this state of things is the option given to builders of saving money in taxation by shutting out air and light.

You would take away that option?—Entirely. I would pass a law to the effect that if a house contained 12 squares on a floor, it should be liable for, say six windows on that floor; but that the owner might open six more windows on that floor if he pleased without additional charge. I have thought long and seriously on this subject, and am convinced that the simple alteration I have proposed, by which the revenue need not lose a shilling, would confer a greater blessing upon the middle and working classes, as regards their habitations, than it would be possible for this Commission to obtain for them in any other way at so cheap a cost. Other means of ameliorating their condition may require local taxes or public grants; but here a great practical improvement may be effected by the stroke of a pen.

WILLIAM DYCE GUTHRIE, Esq., examined.

W. D. Guthrie,
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You have turned your attention a good deal to drainage and other subjects connected with the health of towns, have you not? —I have.

The Commissioners understand your attention has been given to that subject for many years, and you have collected a good deal of information upon it? —I have.

Have you paid special attention to the subject of town sewerage and the cleansing of streets? —I have: being convinced that much sickness results from emanations from decomposing filth, as well on the surface of streets and roads as in the interior of drains and sewers, I have directed my inquiries with a view to discover the best means of remedying the evils.

You have proposed some mechanical improvements for the prevention of the consequences of emanations from sewers, and have turned your attention generally to the improvement of the sewerage in large towns? —I have. My attention has been more especially directed to private drainage, or the sewerage of individual tenements; for I am satisfied the public health is more deleteriously influenced by the exhalations which arise from pent-up matter in them than by those which issue from the great main or common sewer.

You are aware that in some districts of London sewerage is conducted on the system carried on for many years past, and that in other districts a different arrangement, by the introduction of what is called flushing, has been made? —I am aware of the system of flushing in adoption in the Holborn and Finsbury divisions of this metropolis, and I look upon that as a great improvement, for I have had repeated opportunities of judging of its beneficial effects; but I hold every system of flushing to be imperfect which merely hurries along the contents of the principal or main sewers while the putrefying *débris* of inhabited tenements is left undisturbed in house drains.

Have you noticed the emanations from sewers in those different places? —I have.

What is your observation as to their effect on public health; how do they escape? —They escape by the improper position of the gully-gratings, and from these not being trapped. By improper position, I mean the top of an eminence, where no surface water can by possibility accumulate; gratings and gullies are therefore injurious in such situations when untrapped. Two or more of large sizes are frequently to be found where a small one is only required, therefore unnecessary expense has been added to injury.

What do you suggest? —As the *débris* from any tenement can only be carried off by the water which is furnished to it, the size of the tube to carry off that water after the soil is added to it ought

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to bear a direct proportion to the supply of water. The soil-pipe of a water-closet is seldom more than two or three inches in diameter, and the pipe never becomes choked up, for the hydraulic pressure is so great that nothing impinging on the interior surface of the tube can resist its force; all matter is regularly washed off each time the tube is flushed, with even the small quantity of water contained in the basin of a common water-closet.

You think that the size of the internal drains is one material point; that they are made too large, and that they ought to be smaller, that a certain quantity of water, being small, may have an influence upon them?—Yes; and I would beg to direct especial attention to these facts, for I am decidedly of opinion that the great evils of sewers complained of are mainly referable to the errors existing in this department of sewage. The reason why house-drains act so imperfectly, that they frequently get entirely choked up, is simply because their too limited supply of water is spread over so great a surface that its power to carry along matter in suspension is lost. Choking from accumulation seldom takes place in the small iron or lead soil-pipe, neither would such a circumstance ever take place if the calibre of the tube or drains, intended to carry off the soil, were not made so great that the usual allowance of water is unequal to the task of washing out its interior.

What do you think ought to be the form of those drains?—The tubes I would employ for house-drains should be circular, as that form facilitates their manufacture, and they can be made so strong that there need be no apprehension of want of strength in the material.

What diameter do you suggest?—Not more for any ordinary tenement than from three to six inches. On some occasions perhaps a greater diameter may be necessary.

Do you consider that sewers being curved at the bottom is an important point, inasmuch as it gives full action to the water?—The curved invert at the bottom of main sewers is indispensable to their perfect action, and I admire those most which have the segment of a smaller circle at bottom than at top, for the very reason that such an arrangement gives full action to water at the time when it was most needed, viz. when the quantity is smallest. The shape I approve of is that in use in the Finsbury and Holborn commission.

Do you think, with respect to the material that would be required, they should be made of the cheapest material consistently with their being properly constructed?—As cheap as is consistent with sufficient strength of material to resist considerable hydraulic pressure; because, should any obstruction occur (a circumstance which I do not think would ever happen in drains of the description I speak of), that obstruction could be readily removed by cheap hydraulic apparatus.

You spoke of three or six inches for small drains?——Yes.

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Do you think it would be practicable to have those formed of strong drain-tiles, if they were made one part to fit on another?——A cheap arrangement of that kind might be adopted with advantage for properties of small value. Strong drain-tiles, made of good material, and carefully burned, I have seen used in Scotland for sewerage.* These were carefully placed, and continue to operate perfectly, and have been found of sufficient strength to support an incumbent weight of 14 or 15 feet. But I would give a decided preference to perfectly circular tubes of entire pieces in moderate lengths. I would suggest that glazing the interior of these tubes would be an immense improvement, for the smoothness of the glazed surface would vastly facilitate the removal of dirt and filth, and the additional expense would be inconsiderable.

Do you conceive that if so made that would be one of the cheapest and most effectual materials for the humbler classes of houses?——Yes.

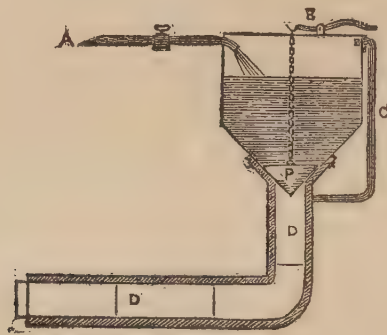
Considerably cheaper than if it were of bricks?——Much cheaper. I would suggest that the interior, even of these coarse tiles, should be glazed, which would not materially add to the cost, and would, for several reasons, be a great improvement.

With regard to carrying out these improvements, have you any other observation to make; do you approve of flushing, and how would you flush?——To suppose any system of flushing would be efficient or perfect, where attention is paid to the common or main sewers alone, while the short connecting drains from houses are left entirely uninfluenced by the body of water which may be passed along the main, would be as absurd as to suppose that perfect surface cleanliness of a large town had been effected because dirt and mud had been removed from the face of the principal streets and thoroughfares, whilst narrow streets, courts, and alleys were entirely neglected. It is idle to expect to effect the desired improvement in health of towns without attention being bestowed in the first instance to both these departments, viz., cleanliness in small drains from houses, and of narrow courts and lanes. This is of primary and paramount importance; therefore I commence with these, and I hope to show that my system of flushing is neither inconsistent with hydraulic laws nor the legitimate flow of sewage. I may here premise that I would lay it down as an axiom that, in the metropolis, cesspools ought under no circumstances to be tolerated, as sources of unnecessary expense and of disease, much less ought they to be propagated by any legal enactments; neither should privies be permitted which have not a supply of water. The mode of flushing which I think superior to any system yet in operation may be thus shortly described: pre-

* *Vide* page 363.

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suming that the existing defects in private drains have been remedied by the substitution of strong tubes of small calibre, and presuming that there is an arrangement in each tenement for carrying off the soil by water, then all that is necessary to secure perfect cleanliness is to erect a water-tank or reservoir, of dimensions suited to each individual case, in such a situation that its contents, when suddenly evacuated, may sweep the whole length of the private sewer, filling completely its interior, and thereby effectually carrying every impurity before it on to the street or common sewer. Houses having water laid on need not be subjected to additional water-rates for a supply to its flushing tank, for if the rain water were conducted to it in the manner represented in this diagram, the purposes of flushing would be



perfectly attained. Let the water from the roof enter the cistern at A, as represented in the woodcut. Should the fall of rain be greater than the cistern is calculated to contain, the surplus may be carried off by the waste-pipe C, on which a valve of simple construction should be placed to prevent the effluvia rising from the drain tube D D. The flushing operation is effected by suddenly depressing the lever B, thereby elevating the plug P at the apex of the conical reservoir, the whole contents of which would immediately rush out with such force as to sweep everything through the house-drains on to the main. This operation will be better understood by a glance at the diagram.

Your plan would be to have a cistern or reservoir of water in each house, so that, on the principle of the water-closet, with a given quantity, you might cleanse the drains attached to the houses?—Yes.

Do you think that could be effected without great cost?—Yes, with those small tubes; reservoirs might be very easily fitted to them.

Do you think it would be more easy with those small tubes?—Yes. A flushing system, such as that I propose, would be inefficient with the large house-drains now in existence: it would be impossible to wash out clean a tube of 18 inches or 2 feet, and especially where the bottom is square and rough at the sides as

well as the bottom ; but roughness exists in all brick-built sewers, more or less. If the system of flushing private drains were adopted, flushing the main sewers would scarcely, if at all, be necessary.

Do you contemplate privies communicating with the main sewer, so that the soil might pass off?—No ; I would not tolerate such dirty, unwholesome, and offensive things, under any circumstances, in the metropolis, as water can be had.

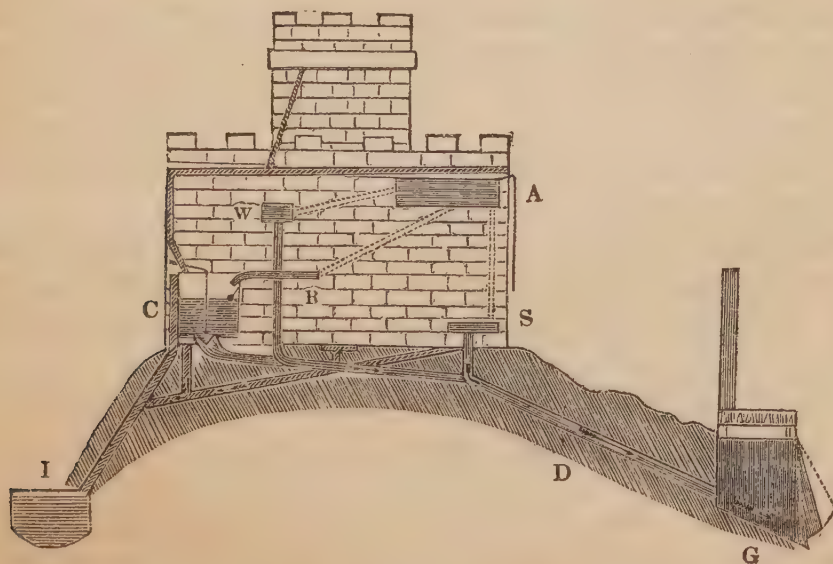
You would suppose that in each of those dwellings there is a water-closet, or some convenience of that nature?—Yes.

Have you made any calculation of the comparative cost of those for the dwellings of the humbler classes, as compared with a privy, and the ordinary mode of cleansing it out by hand from time to time?—I have not ; but minute calculations are given in Mr. Chadwick's Sanatory Report, which show that, setting aside the improvements on the score of health, the economy would be greater from adopting the ordinary arrangements of water-closets than the expense incurred directly from the frequency with which those places are required to be cleansed out.

Do you believe those calculations to be correct?—I do.

Do you believe that by some improvements much of the surface water, the water that falls on roofs, and so on, might be properly distributed and made available for the purposes to which you refer?—I have here a sort of rough diagram, which shows the mode I would propose for collecting the surface water.

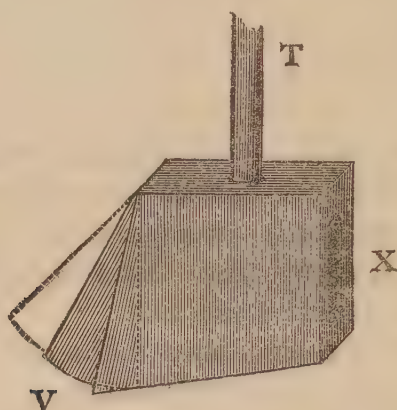
The principal feature of the arrangements here delineated, is the mode of carrying off surface-water either by the soil-drain or by a different channel altogether. Let A represent a cistern supplied



by water laid on, from which W, a water-closet, and S, a sink, may be supplied. These conveniences may be as few or as numerous as the case may require. Then the rain-water may be conducted to the reservoir or flushing tank C, which should be

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arranged as shown before. It will be at once seen how effectually the whole length of the soil-drain, from C to G, must be washed out by the contents of the flushing tank rolling along with an impetuosity depending on quantity of water, inclination of sewer, &c. G, in this diagram, is intended to represent a valved chamber, so contrived as readily to admit of the escape of sewage, but to arrest effluvia and subject all noxious gases to such an amount of temperature as shall render them in no degree more deleterious to health than the ordinary products of combustion. The annexed diagram represents the valved chamber:—



You produce that plan to make it apparent that in this climate, where there is a good deal of rain and surface water, that might go a considerable way towards supplying the flushing system, and for the use of the family?—Yes, if duly economized; and where water is laid on, the cistern very often flows over; in that case the surplus water might be carried to another, which might be separately applied for flushing.

Have you made any calculation of the expense?—I have not.

Do you believe that, combining efficiency with economy, it may be brought within the reach of the humbler classes?—I think that no tenement to which water is not intended to be laid on, should be built without being furnished with a reservoir for rain water, because where water is not laid on, rain water, thus economized, would be sufficient to flush or wash out the drains from time to time. Another advantage of rain tanks would be, that the damage frequently done by surface water running at once into the main sewer, causing its overflow and consequent flooding of districts, would be prevented.

By that plan the water which falls in a great body at one time would be economized, so as to make it available for sanitary purposes?—Yes.

What quantity of rain water falls in this locality, on the average, per annum?—Twenty-seven inches, if I mistake not.

What is the difference of expense of the pipe drain compared with the ordinary brick drain?—The following is a rough estimate of the cost of tubes of terra cotta:—

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	Ft.	In.		Ft.	In.	s.	d.
Tubes of	1	6	in length, and	1	6	in diameter	7 6
Ditto	2	0	ditto	1	4	ditto	6 6
Ditto	1	6	ditto	1	0	ditto	2 3
Ditto	1	6	ditto	0	9	ditto	1 6
Ditto	1	6	ditto	0	6	ditto	1 0
Ditto	1	6	ditto	0	3	ditto	0 8

Tubes of common clay in two-feet lengths, and of the diameters as under might, in London, cost as below :—

	Ft.	In.		s.	d.
Tube	1	0	diameter	1	6
Ditto	0	9	ditto	1	0
Ditto	0	8	ditto	0	10
Ditto	0	6	ditto	0	8
Ditto	0	4	ditto	0	7
Ditto	0	3	ditto	0	6

What do you conceive would be, from your own experience, the best size for the dwelling of a mechanic, or a person in the humbler classes of life, with an ordinary family?—That would depend upon whether he might have water laid on from a Company or have merely to depend upon surface water; four inches would be sufficient if he had a water-closet supplied with water by a Company.

What would be the corresponding expense for the brick?—I object to the brick-built private drain entirely, because there the largeness of the calibre, of which I disapprove, would come into operation, and the flushing system suited for tubular sewage would, in that case, be utterly inefficient.

The adoption of proper traps for those drains is material for the purpose of giving operation to this flushing system you have spoken of?—Yes.

Would it not be another objection to the adoption of bricks for a drain of that size, that they would be rough inside?—That is an objection which pertains to drains of considerable diameter only, because tubes of the small calibre I speak of could not be built of common brick at all.

Another objection to brick-built drains is the space being much greater?—Yes; and they are never so perfectly constructed as to prevent the permeation of gases, which could not take place in glazed tubes, at least to any appreciable extent.

Would it not be much more readily kept in repair under the supervision of one individual?—I have no doubt of that.

One person so appointed would be answerable for its construction and the keeping it in order?—Yes.

If left to the care of each individual owner or occupier, you think it would be neglected?—At present private sewers are frequently neglected.

There is no mode of arranging the connexion with the main sewer adopted, but one is made on one principle and one on another,

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with different forms and different falls?—Yes; it was that referred to, when I proposed the appointment of a person qualified to direct these operations.

From that very circumstance the decomposition of various injurious matters arise?—Yes.

Do you think that the person appointed to superintend those connecting drains should be employed by the Sewers Department?—Yes; at present the Commissioners of Sewers have nothing to do with private drains, hence they are allowed to choke up till they frequently become so offensive that either landlord or tenant is obliged, for the sake of health and comfort, to attend to them. The proper construction of house-drains builders are not at all particular about; they make them frequently of the worst of materials, with a flat bottom, imperfectly covered with flat stones, badly jointed and seldom cemented. The obvious reason why sewers, generally speaking, become so very offensive immediately after thunder showers, at this season of the year, is because the surface water collected from the roofs coming down in unusual quantities, hurries towards the main sewers those putrid accumulations, which bad drains must contain, and which are not likely to be removed but by some such casualty; by my system no such accumulations could take place.

Do you not think that the adoption of some system for those private drains, under the supervision of a skilful person, would prevent the inconvenience of frequently having to look after, and to repair and alter those drains inefficiently made by the builders?—I do; and I am so impressed with the importance that should be attached to the construction of house-drains, that I think too much attention cannot be paid to this department; but I would beg to remark, that drains on the small tubular system, if once made of approved materials, such as I have alluded to, which could not be decomposed by chemical action, would seldom, if ever, require repairs; but should, by any accident, a tubular drain become choked, a very simple mode might be adopted to clean it out, when such may be rendered necessary, on the same principle as chimney-vents are cleaned by the new and improved mode. Drains could be easily made in such a way as to admit the application of an apparatus of that description being passed from the one end to the other, and so cleaned out completely without requiring the surface to be broken at all.

Do you apprehend that if they were properly constructed the water would be a sufficient agent to keep them clean?—I have not the least doubt it would. I do not apprehend there would be the least chance of choking, and I only mention the plan of cleaning out to show how simply that might be accomplished; I may add, that though choking might even take place, offensive emanations could not take place from glazed tubes.

Your opinion is that, as regards the original construction, for cheapness, for efficiency, and for keeping free from everything deleterious to health, the tubular pipes supplied with water would be the cheapest and best?—Yes; a grand point would be gained by the adoption of tubular drains in the economy of water. Another advantage of my form of house-drains would be, the saving of expense effected by the causing the drains of several houses to converge to a point opposite the centre house, at which point only would it be necessary to have an opening into the main sewer. The private drainage of a whole row might in the same manner converge to particular points at which it would enter the main sewer; by this arrangement one flap or valve would suffice to prevent the escape into the houses of any emanations from the main sewers. The economy of large valves for entrances into the main sewers would of itself be important. I propose, however, a small valve to be placed where it may be thought most convenient on each house-drain. Those valves and flaps at present in use are generally objectionable on the score of expense, which arises from their size being unnecessarily great; and their weight, being of metal, must be increased to suit the size, which causes imperfection in their operation. I approve of slate flaps, such as I have seen in the Holborn division of sewers; but I would propose well-burnt plates of common clay, fire clay, or terra cotta, which have the advantage of being readily moulded into the most efficient form. The advantages of flaps of these materials are that, being of less weight than iron, they are more perfect in their action, and are lifted by a smaller run of water; that they are not affected by chemical action, and therefore are not decomposed as iron is, by the gases and moisture by which they are surrounded, and that they are originally less expensive than iron, such as those now in use.

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What do you find to be the effect of drainage from a privy or a pool into a sewer, where there are not proper supplies of water to flush or cleanse the drain, which communicates from the privy or the cesspool into the main sewer?—The evil is undoubtedly greater; the emanations are increased, because to the extent of the surface accumulations in the private drain and of the cesspool, there is added the gaseous accumulations from the street sewer. A communication by a drain from the sewer brings into a house the emanations from a whole district. This is the case in some parts of the metropolis, where the effect is produced by strong southerly winds, which blow into the mouths of sewers opening into the river, and carry a backward current of emanations into the houses and streets of the upper parts of the district, where the drains or gullies are untrapped. So invariably is this the case in narrow streets and densely crowded districts sheltered from the wind, that the inhabitants commonly infer a change of the wind from the

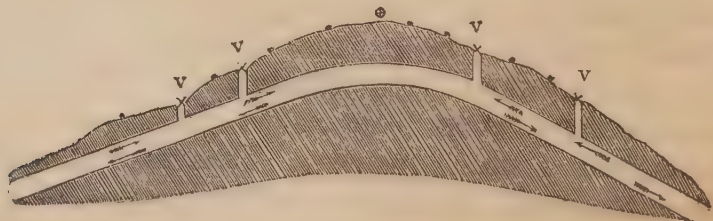
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offensiveness of the drains and the sewers. Hence the tenantry of the districts newly sewered and drained complain that they are worse off after the sewerage than before, where the sewers are so constructed as to allow of accumulations, and the drains are inadequately supplied with water. However constructed, it must be so, inasmuch as all the expense incurred has only brought them an addition to the surface emanations from their own privies or cess-pools. Even in houses of the highest class, where they have water-closets, but where the drains and sewers to the houses are not properly trapped, severe illness and fever are frequently inflicted, by the escape of emanations, on the servants who sleep in the lower apartments where sinks are placed.

You recommend that every drain should have a trap, to prevent the smell ascending to the houses?—As matters at present stand, it is clear that all house-drains should be furnished with traps or valves of some description, to prevent the escape of deleterious emanations; but I do not think that if the system I propose were adopted, such would be so indispensably necessary. I look upon the gases being disengaged as a positive proof that the sewerage is imperfect. It is a proof that the *débris* of houses must be detained somewhere, and that decomposition has been allowed to take place; whereas, if animal or vegetable matter were to be immediately and sufficiently diluted, and rapidly hurried through the whole system of sewers, there would most assuredly be less necessity for traps or valves; I think it is possible they could then be dispensed with entirely; however, my small valve for the small tubes can be placed on a tube at any time and at little cost.

Do you think that in the usual condition of matter carried away by a drain, though the air might not be surcharged with putrid materials, still it might be sufficiently offensive to render it desirable that it should be withdrawn or prevented entering houses?—Certainly I do.

Have you paid attention to some modes of withdrawing the air and consuming it?—I have. I have a diagram here to



show that if a system of valves or traps were to be used along the main sewers, the gases could then be hurried on or drawn towards the mouth where the sewers debouch, and when there, a particular contrivance might be adopted to arrest the gases, and they might be decomposed by the application of temperature.

The public health would then suffer in no greater degree than from the ordinary products of combustion. This shows the manner in which sewage travels along the bottom of a sewer, while the gases disengaged by putrefaction take an upward course. The letters V denote the places proper for gullies, all of which should be valved. The dark spots are placed where open gratings at present exist in localities where no surface water can collect and should therefore be shut up.

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You have examined some of the arrangements of the Houses of Parliament?—I have studied Dr. Reid's diagrams.

Have you noticed the nature of the communications from the drains?—No.

You have no doubt of the economy of that arrangement you have illustrated, if opportunity were given for it?—No doubt of its perfect efficiency.

Have you paid attention to the formation of the gully-drains; are they properly constructed at present, or do you see any objection to their present construction?—There are some of a more perfect description than others; but the construction and placing of the gully-drains I have noticed as being generally extremely defective—perpendicular shafts turning off at obtuse angles, causing accumulations, which rapidly become offensive; these gully-holes rarely have flaps or valves. Another defect is that the gratings are so placed that a fall of water will not have the effect of removing accumulations from the bottom of the perpendicular shafts. The position also of the gullies is, in many instances, highly injudicious, in respect that they are often on elevations where no accumulation of surface water (which it is the object of the gully-shoot to remove) can by possibility occur. They are also, as being untrapped, prejudiciously numerous.

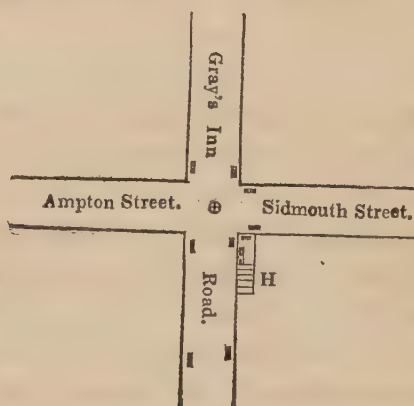
What should you propose as an improvement?—I would condemn and shut up all gullies on the crowns of eminences, and reduce their numbers, generally, as far as practicable; those having angles occurring in their course, which cannot be avoided on account of gas or water-pipes coming in the way, must be allowed to continue, but should be valved. I would recommend that in all cases where new gullies are to be formed, that they should be made straight, so that when accumulations occurred they might (by opening a hinged grating) easily be pushed forward into the main sewer by a simple apparatus for the purpose; whereas straw or sand, or whatever might accumulate in the interior of the crooked 18-inch drains, cannot be removed without sending a person into the interior: they are made for the express purpose of allowing a person to crawl through the tube to remove those obstructions, which must occur from their large size.

You think that by making them smaller and without angles

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you might avoid the obstructions which occasion the necessity of persons going in to remove them?—Yes; and should obstruction occur, there would be no difficulty in inventing mechanical contrivances for its removal.

You think there might be considerable improvement made in them?—Yes; and there are many of them placed in such localities: they can be of no use whatever. I annex a diagram of what takes place in Sidmouth-place, Gray's-inn-lane, where, within 50 yards of the corner house, there are 11 open or untrapped gratings over drains.



What improvement do you suggest as to preventing the smell coming up there?—I would have the whole of those gratings found to be improperly placed shut up altogether.

Where there is a sewer and water going down, what would you have?—I would have a grating and a valve.

Supposing you adopted these improvements in the general system of the drainage, would they, in your opinion, be efficient without the flushing?—Perhaps not without the flushing I have described for removing impurities from house-drains.

In what mode are those drains now cleared when obstructions take place?—By men going into them.

If that still continued, it would render the difficulty of going into them greater than it is at present?—Yes, but it is a difficulty which might be got over; if men can breathe under water, respiration may be carried on in a contaminated atmosphere.

Would not the introduction of water with the system of flushing be analogous to the destruction of bad air in mines by water?—I think not quite analogous, because sewerage contains so great an amount of sulphuretted hydrogen, that I do not think any quantity of water that is likely to be added would absorb much of that gas already disengaged. The effect of turning water into sewers would be beneficial principally on account of its flooding operation.

Would not the introduction of a stream of water from time to

time have the effect of disturbing the stagnant air, and have the effect of carrying it off?—Water introduced in the manner I have explained certainly would, and would have the effect of preventing its formation, if the system were perfectly carried out; and certainly, should it accumulate, it would be hurried towards the proposed outlets.

Therefore, the adoption of the system of flushing you speak of would have the effect of preventing the accumulation of matter within the drains, which generates bad air, and of disturbing the air and carrying it off?—It would.

And of arresting decomposition by cold water?—Decomposition would be retarded by the lowness of the temperature of the water introduced.

Have you made any calculation of the cost of the system of flushing, as adopted in any districts you have noticed?—No, I have not.

Do you think your proposal practicable, without great difficulty?—Without any difficulty; and the expense, I am satisfied, would be very inconsiderable.

Is it your opinion that the flushing and carrying away of the refuse by water is much cheaper?—I have not calculated the difference, but I believe it would be cheaper; and I confidently assert it would be incomparably better.

That system has the advantage, not only of being cheaper, but of removing those bad smells, and making it much healthier as well?—If we take for granted the economy, no doubt then it combines the two advantages.

A certain supply of water would be absolutely necessary for the system?—Certainly; it would be indispensably necessary.

Would the water that falls be sufficient for the purpose of flushing and cleansing the main-drains in the districts through which they pass?—I have not the least doubt of that.

You think it better that the sewers should not be larger than would contain the largest quantity of water that may fall?—There is no necessity for their being larger than that they may be pretty nearly filled, when there is a great deal of rain, so that any impurities adhering to the upper parts of the interior may be washed off the tube.

To act, in fact, as a natural flushing?—Yes.

What form would you recommend for the secondary drains, such as are to receive a number of small ones?—I think the form adopted by the Holborn and Finsbury Commissioners is the better form.

You recommend the form of the different descriptions of drain adopted by the Finsbury district?—Yes; they are variously shaped.

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That gives greater strength?—The greatest strength is by that form secured, and it has the additional advantage of rendering efficient a small quantity of water, the apex being turned downwards.

Have you paid any attention to the construction of water-valves for the drains immediately communicating with the dwellings?—I disapprove of water-valves, because of the malaria which arises from the water they contain, when it becomes putrid.

Do you consider it of importance that they should be so placed as to be easily got at to be cleansed?—I do.

By valve, do you mean the hinged flap?—Yes; which is all that would be necessary for a private sewer.

In reference to this method of flushing drainage of which you have been speaking, do you consider that as applicable to the old drains as they at present exist, or would it be necessary to renew them before that could be introduced?—The main-drains would require no alteration, save those they are re-arranging at present, which have flat bottoms.

Then it would be necessary to reconstruct all those which have the square shape?—Yes; they would require to be altered under any circumstances, but certainly not more necessarily by the system of flushing I propose.

Have you considered at all the expense of adopting those alterations?—No; but I do not think it would be great; the expense of the tubing necessary would be very inconsiderable indeed, and I would propose that the present brick-built private drains should be well cleaned out, and smaller tubes placed in the interior of them. I would allow them to remain in all cases where it is practicable; I would place a tube in the centre, and surround it with clay, or some cheap material.

The question refers to the large main sewers; would it be necessary to alter them?—No, not at all, save where they are flat bottomed; those old private drains, those over which the Commissioners have no surveillance, are the drains in which so much alteration and improvement is necessary. The new form adopted by the Westminster Commissioners may be sufficiently perfect, but I rather prefer that adopted by the Holborn and Finsbury Commissioners, though either is perfectly available for the system of flushing.

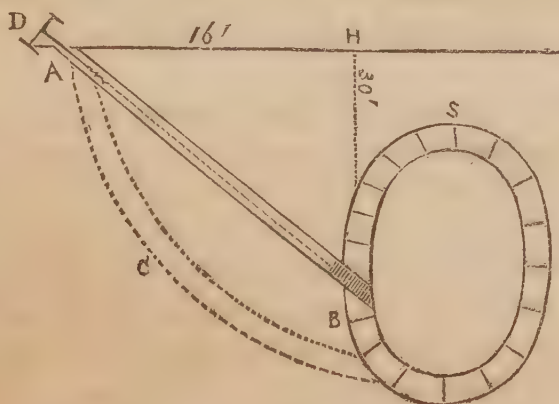
The system in Westminster is to have a cove at the bottom, but not in the same manner?—Their invert is a segment of the same sized circle as the arch at top; I believe it is not less, at all events.

Have you paid attention to those parts of the metropolis where there are no drains at the present moment, such as some parts of the north and in the east of London particularly?—I have

Have you turned your attention to Whitechapel or Bethnal-green?—No, I have not.

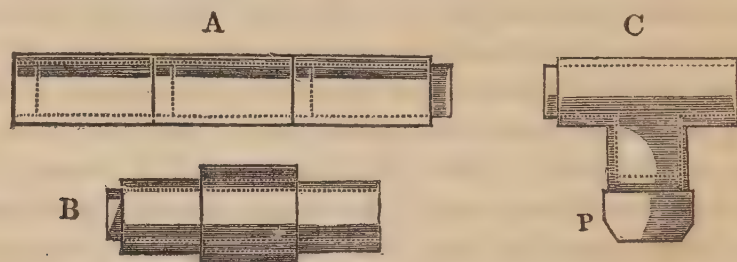
Have you considered in what way a remedy could be devised for the imperfections of those gully-drains which would not be too expensive?—I should propose shutting up all those drains which are inefficient and improperly placed; and I find, on a moderate calculation, that the sum that would be realized by the iron of the condemned gratings would be sufficient to make the arrangements that ought to be adopted in respect of placing cheap valves on all those side or gully-drains allowed to remain; the expense of those valves would be more than covered by the value of the old material. There are several thousand gratings which are utterly useless on account of their position, and positively injurious from their emanations.

They are introduced for the admission of the surface water?—They are; but I conceive them to be a great deal too large; and they are frequently placed in such a manner that they become inefficient for the purpose for which they were placed: the water percolates down one edge only through the sand and dust, carrying none of them along with it, till by and by they become choked up. In some of the best parts of London—I allude to Regent-street and Portland-place—this is to be observed: there was not, at the time I made my observations, in these streets one gully-drain in twenty that was not greatly choked up, and that too during the late heavy falls of rain, showing that even vast quantities of rain falling were not sufficient to keep the drains open. The expense is very considerable indeed in having those gully-drains cleared out from time to time. Here is represented a plan for *boring* down to the main, instead of the present expensive and tedious mode of excavating. At the corner of Vernon-street, it was thought necessary to place a gully-drain and grating; the operations were protracted to a period of not less than five or six days; the space excavated being 30 feet by 16 feet, marked by the lines A to H and H to B. By the mode of boring and inserting tubes as here delineated, a conduit for surface water might have been finished in a few hours, which could be cleaned with facility by passing a straight rod through it.



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Is it your opinion that it would be better to have a sewerage to receive the surface water, immediately from the street, separate from the entrances of any drains coming from the houses?— I think that, instead of having at each grating a direct communication with the common sewer or gully-drain, many of them along the edge of a descent might be united ; one small tube carried along and receiving the collections of several gratings, for a distance depending on circumstances, so that one direct communication into the main sewer, and one valve placed on that and not on every one. Figure A represents the form and appearance of tubes of earthenware, and B the mode of joining or repairing, should by accident a length be broken. Figure C shows the form to be given to lengths which are intended to be placed where unions are required. P, the plug, being fixed with pitch only, can be removed readily, and a connecting tube attached.



Have you paid any attention to the construction of water-traps, whether they could be easily cleansed?—I should object to them on the score that the water itself, when accumulated, carries along with it, as it must necessarily do, great impurities, which undergo decomposition and become offensive ; and I am not sure that the evil arising from this circumstance might not be as offensive as that sought to be removed. It is very simple and very efficient otherwise. I should prefer the principle of a hinge valve.

Have you paid attention to the surface cleansing of streets and alleys and courts?—I have.

Do you think it might be more efficiently done, and in a cheaper mode, by water cleansing?—Yes ; I think that would be the cheapest and most effectual.

Do you think that might be carried off by means of the common sewers?—Yes.

You would have no fear of their being stopped?—None, if they were properly flushed.

You would consider that the dirt and filth before the doors of houses and so forth, from each house, and the street dirt from the surface, and whatever is brought down by the kennels, might be carried off effectually?—I have not the least doubt of that.

You think that would be cheaper than the present mode of carting it off from time to time?—Yes.

Have you made any calculation of the expense?—I have not myself. W. D. Guthrie,
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Have you made any calculation of the expense of the sort of apparatus you just referred to?—Many mechanical arrangements for that purpose might be easily made; a sketch of the water-valve itself might be very easily prepared, with a floating ball and stop-cock, the same as the common stop-cock for cisterns.

Have you seen any mechanical contrivance for the cleansing of streets?—In Glasgow, in 1840, I proposed an improved mode of street cleansing, which I submitted to the Board of Commissioners of Police; but they did not conceive themselves warranted in ordering any expenditure of the public money for an experiment, having once already failed in the attempt to complete a sweeping machine of practical value. I have seen Mr. Whitworth's in operation.

Do you think that might be effectual with the aid of water?—I think that if manual labour were economized, it would be cheaper and more efficient than almost any mechanical contrivance (supposing no water from companies to be used), by simply taking advantage of the heavy rains that occasionally occur, if it were permitted that the *débris* should be swept into the main sewers.

Do you think that the slop and filth might be swept into the gully-holes, and that it might all be carried off by means of flushes?—That would be the most efficient mode.

Do you apprehend that from any such cause any accumulation might take place in the bed of the river?—I believe that to some extent such might be the case; but I do not apprehend it would be very prejudicial to the shipping interest supposing the whole of the *débris* of the metropolis were to be carried into the river.

Are you aware, that in consequence of the removal of the Old London Bridge, the depth of the river has considerably increased of late years?—I am aware of that fact.

What would be the expense per yard for a drain of the cheapest and best construction,—what you would call the collateral drain?—I should imagine that a drain from the diameter of 12 to 16 inches would be sufficient to carry off everything from the humbler dwellings of a short court, for example, consisting of 20 houses on either side.

Is it not preferable to have it deeper in its section?—Tubes made in one continuous piece, probably of a circular form, would be as strong as any.

Take the expense of a circular form; regarding that, what would be the cost per yard?—About 8s.

Of what would that be formed?—Tubes of so large a diameter as 12 or 18 inches would require to be formed of the clay they use for common earthenware. The prices in these lists are not so

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low as tubes could be had for, if they were required in large quantities.

What number of tenements of that size would such a tube be sufficient to serve?—That I have not calculated.

There must be a proportion between the size of the drain and the number of houses to be served?—Of course there must. The calculation required is the number of houses, the quantity of water likely to be collected from the roofs, the quantity of water from each tenement laid on, and the fall.

Would it be difficult to make such a calculation?—I should say not.

Would a drain of that size be sufficient to take the *débris* from 20 houses on each side, and to carry away, if properly supplied with water, that which runs from each of them?—I should have no doubt it would.

Would the same diameter of drain carry off a greater quantity of matter if it has a better inclination than if it has a smaller inclination?—Of course, the nearer to the perpendicular the better.

Then you must take into consideration the fall as well as the capacity of the drain?—Yes.

Have you made a calculation, having as much fall as will be desirable, and a sufficient supply of water, what would be the cost of drains of one or two capacities, and the number of houses they would accommodate?—That I can very easily furnish.

You stated that, on a rough calculation, there is no doubt a drain made as you have stated, would take the refuse from 20 houses on each side?—Yes.

Have you known any cases of actual illness by retrograde currents into tenements from house-drains?—Yes; in a particular part of the district in Sidmouth-street, as marked in the diagram, there were three servants in one house who were taken ill with fever and removed, and five of the family of children were also seized, and one died, as I apprehend, of that cause. In Gray's Inn-road another family had fever, but of a more mild form; that was more remote from this particular concentrated spot; but, by-and-by, the same family that had the measles here, removed into the very house where this system of sewerage exists, and three children were immediately seized with scarlatina, and one died.

You have given the Commissioners the cost as 8s. per yard of the pipe-drain for the purpose of receiving tubular drains from particular dwellings; what will be the thickness of the pipe-drain?—I am not so very certain of that; I do not know that such tubes are at present in existence; I found great difficulty in getting exact information from the persons to whom I applied.

Supposing you had the tubular drains you speak of, what would be their thickness?—That would of course depend greatly on the quality of the material used; coarse clay would require to be

from half an inch to an inch in thickness, and perhaps even greater than that. W. D. Guthrie,
Esq.

It would be only necessary to cut the width of its extreme diameter to put it down?—Nothing more.

But if they were constructed of bricks there must be a cut of much greater width and depth?—Yes; of greater width, certainly.

The cut in one case would be much more expensive than in the other?—Yes; but the great economy of the tubular system would be the rapidity with which the operations could be completed, for the tubes might be placed *in situ* as rapidly as the necessary excavations were completed; you have nothing to do but to place them on the floor of the cut intended for their reception; a vast contrast from the common mode of brick-building, which is a tedious labour; of that kind, too, which men can work at only for a few hours in daylight.

Does not the same principle of tubular drains being laid with greater rapidity, and requiring less width and less depth in cutting, apply equally to the drain in the middle of the street as to the small drains communicating with it?—It would; but I beg that it may be understood that I do not speak so confidently of the success which might attend the adoption of tubes of large calibre, of 18 inches or two feet diameter; I have not yet had time or opportunities to acquire sufficient information regarding them to speak decidedly.

Would it require to be so deep under the surface as the other? —There must be a certain fall to carry off the soil from the tenements, and the greater that is, of course so much the better for the main tube.

Do you not apprehend that a tube properly constructed, and especially glazed inside, would not require so great a fall to empty it?—I have no doubt that a tube of that kind would operate efficiently with a less fall than any brick-built drain.

It would be much less costly on account of the material taking up a less space, and the fall being less?—Yes, much less; the expense of blocking up the principal streets and thoroughfares, too, would be very much lessened, instead of having for a great length of time the tedious brick building going on, to the great loss of persons in business and inconvenience of passengers.

Do you contemplate that, in consequence of having a much narrower sewer with an improved method of tubes down a certain street, instead of its being carried up the centre of the street, and preventing the passage of carts and carriages, it might be carried in some streets on the side, so as to leave a sufficient width for the carts or carriages to pass on the other side?—I think the inconvenience that would be saved to the community by the blocking up of the street during the laying down of the main would not be materially remedied in that case, because the street would be

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blocked up on every occasion when a connection was required to be made from a house on the more distant side of the street, which I think would more than counterbalance any advantages which that plan would possess; I think the best situation for a main sewer is the centre of the street.

Have you paid attention to the depth at which those main-drains should be placed to preserve them from frost?—I asked a practical man whether three feet under the surface would not be sufficient; and he said he thought that, under all the circumstances, three feet would be sufficient to prevent the action of the frost, and to prevent the tubes being broken by concussion by the fall of heavy bodies, which was one of the objections made to tubes of the material I proposed; of course to prevent such an accident they must necessarily be placed at a sufficient depth.

Would you recommend that they should pass under the water and gas-pipes?—Under these, so as to be out of the way of the operations of gas-fitters and water-companies; for, as I have before stated, their being composed of material that would not decompose, repairs could not be required.

Are you aware that in ill-constructed drains,—square, &c.,—made of brick, rats infest them sometimes in vast numbers?—I am aware of that.

Then they would be cleared out, and their access to dwellings would be prevented?—Yes; with glazed pipes particularly, it would be impossible for them to cling on, especially when a flushing operation overtook them. In Scotland an instance occurred in the town of Montrose, 10 or 12 years ago, about this season of the year. A violent thunder-storm occurred, accompanied by an extraordinary fall of rain; the water from the immediate neighbourhood, and from the roofs of the houses, so rapidly accumulated as to completely gorge the sewers, which had a mortal effect on the rats in the interior; thousands, to the extent of cart-loads even, were destroyed by that one grand natural flush.

The quantity of rats in many of the sewers is a serious annoyance, on account of the damage they do by making holes?—The holes they make allow the percolation of sewage, when heavy rains occur, sufficient to raise the sewage beyond the ordinary level, below which a rat generally takes care never to burrow.

Any system of improved sewage, which would take away the temptation to the rats to come up there and prevent their remaining, would be a serious benefit?—Certainly it would.

You consider it very important that the sewers of the largest class should, if possible, be made air-tight?—Certainly I do.

Have you paid any attention to the best mode of effecting that with certainty?—I have not turned my attention particularly to that point, but I presume by the liberal use of common cement they may be rendered tolerably so.

Is that equal with pitch?—Perhaps pitch might be preferable if the exact configuration were given to the bricks which the form of the sewer required. In that case if some bituminous substance, instead of ordinary cement, were placed between the bricks, it would be more inimical to the permeation of gases or escape of noxious emanations than the system which at present prevails. I may notice that they do not put cement on the upper part of the sewer; they cement only the under portion, where the friction of the water occurs, which only prevents the percolation of water.

Do you consider that any extent of flushing, unless effected with an extreme quantity of water, will remove foetid gases from large sewers?—Unless the quantity of water was very large, I am satisfied that it would not; and however perfect the system of flushing may be, decomposition to some extent must go on, as one of the effects resulting from the practice in large towns, where they have steam-engines turning in condensed steam and water at a very high temperature into the sewers; such a thing occurs in the top of Leather-lane, where Reid's brewery is; you can see the gratings down the whole of that side of the street smoking and emitting with the vapour an effluvium of the most offensive kind.

Is not that very common in many parts of London?—Yes; in all cases where steam operations are conducted, and water at a high temperature is turned into the main sewer. They have no other mode of getting rid of it, and I consider it to be the cause why in such neighbourhoods decomposition is more rapid than where the sewage passes along at a lower temperature.

Practically speaking, deleterious or offensive gases must be always presumed to be present in drains?—Yes.

You might have a current of water descending, and a current of air ascending in a main?—I have endeavoured to show that such is the fact, in the diagram, to account for the sickness in Sidmouth-place by that very circumstance. Here is represented a current of water, carrying the grosser offensive matter downwards; but then a current of air is supposed to be rushing upwards, which air of course escapes whenever such favourable opportunities occur as untrapped gully-drains, or those passages which proceed from the crown of the sewer directly to the surface of the street, called ventilators.

Offensive air is always escaping from every untrapped gully-hole?—There is not the least doubt of it.

You are perfectly aware that that operates to a great extent in producing disease in London?—I believe it does.

Would not the state of the drains be infinitely less offensive, and much less prone to produce disease, were little channels provided, by which at certain intervals currents of air might be driven perpetually through the drain, so as to oxygenize those gases?

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—There is no doubt that any measure of that kind would materially tend to ameliorate the public health by preventing the occurrence of sickness.

You have spoken of a chimney for the discharge of gases; do you not think it would be better to place it at the higher part of the sewer?—I think the most effective mode of ventilating would be to have many small tubes from the crowns of the sewers; these might be laid towards either side of the street, and be carried as high as the tops of house chimneys; the gases would thus be discharged high in the air, and the atmosphere required for respiration would not then be contaminated as it is at present by those ventilators which pour forth the gases from the sides or centres of the streets. No mode of ventilating can be more unscientific than the present boasted, though obnoxious system of grated openings in the streets. Tubes, however, might be attached to these, and carried high in all practical localities. Tubes of six or eight inches diameter would be sufficient, and the cost of many thousand yards of these would not equal the expense of a single large chimney-stalk. I am of opinion that ventilation would be much more perfect by numerous small discharges than by one colossal ventilator intended for an extensive district. Large quantities of gas would be carried along to the mouths of sewers, even supposing such ventilators as I speak of were in operation. This may be inferred from the fact that the atmosphere along the banks of the Thames is greatly vitiated by the dissipation of malaria, although every opportunity is afforded for the escape of the gases along the whole line of sewers, so that arrangements for collecting and destroying them at these debouching points would still be required.

Do you think that arises from the immediate discharge of gas from the sewer, or the offensive matter thrown into the river?—Partly from one and partly from the other.

An arrangement for collecting and destroying the gases might facilitate the descent of air to a certain extent?—Yes.

If large chimneys or discharges of any kind were placed at the higher levels, would not that form a natural eddy draining itself, particularly in the night season, perpetually discharging at the highest level?—I have not the smallest doubt it would, without any additional temperature, without the expensive arrangements required for active combustion to increase the draught.

Are you aware of any changes in water by which it is particularly affected with a particular form of noxious ingredient?—During the thunder-showers probably the electrical condition of the atmosphere and of rain water would expedite decomposition.

Is it not the case, that in all cases where the mouth of the sewer is closed by the river by a high tide, whenever the water accumulates, the pent-up gas in the interior must be forced out at

some gully-hole or private drain?——Yes; it is the case at present. W. D. Guthrie Esq.

On that account alone it appears essential in a low level to have some discharge?——It was with that impression that I constructed the diagram I exhibited before, to show how their dissipation along the banks of the Thames might be prevented.—*Vide* valved chamber G, in the second vignette.

V.

DRAINAGE OF BUILDINGS, IMPROVEMENTS IN THEIR STRUCTURAL ARRANGEMENTS, THE CHARGES CONSEQUENT THEREON, AND THE MEANS OF LIGHTENING THE BURTHEN OF THEM.

Mr. Thomas
Cubitt.

MR. THOMAS CUBITT, examined.

IT has been proposed to require that all courts and alleys should be at least 30 feet wide, if they are not open at both ends. Do you consider such a regulation to be too restrictive, or would you make any alterations in it?—If I made any alteration in it, it would be to make the streets and alleys wider; in fact I would have every place so that a cart would have easy access for clearing away the dirt. I would have no house built where there was not a public way, and the entrance open to the sky.

Do you consider that it would be desirable to enforce by legislative enactment, that no houses should be built back to back?—I would rather leave that open, and let people do as they like. I think that building them back to back is a much cheaper mode, and that if we were to prevent their being built back to back, we might in many cases prevent houses being built, which would be a great accommodation to poor people.

Have you not yourself built a considerable number of houses of the class referred to?—I have built very few houses for poor people, but when I do, I try to make them as healthy as possible.

Have you ever built them back to back?—Never.

You would not recommend that mode of building, but would not be inclined to prohibit it?—No; I should be afraid of making the law too restrictive.

If you allowed houses to be built back to back, what regulation would you make as to the erection of privies?—I think I should be disposed to leave that to the people themselves, taking care that there are no narrow courts, that they are all open and broad spaces, and every house at least should have a privy; but I should leave it to themselves where they should put it.

If two rows of houses were placed back to back, in what position ought those privies to be placed?—They might do it by making a water-closet in the upper part of the house without being offensive or injurious, or there might be water-closets in other parts.

Would it be possible, consistently with the economy necessary in the construction of poor houses, to have a water-closet to every house?—If it were made a law, many people would very much

object to it, but I think, if left to themselves, many would adopt it. I think the public is not yet prepared to go to that extent; in the erection of buildings, there are 10 water-closets put up now where there was only one 20 years ago.

Has it been your habit, in the construction of buildings of an inferior class, to place water-closets in them?—I scarcely build any house, however small, without having a water-closet attached to it, and not a common privy. I believe the last 20 years I have not built any stable or coach-house, in which accommodation has been made for persons to live, without making a water-closet in the upper story; and I found that the mews in which those stables have been built has been generally kept clean: the effect has been that they would do all their dirty work within, and keep every thing offensive out of sight; and that the mews has been very neat and consequently the place more healthy. The places I have built are generally very free from any bad smell, and there is nothing worse there than the stable dung.

Can you state what is the expense of putting up a water-closet of the cheapest construction?—There is a cheaper kind of water-closet than I have fixed. I am hardly prepared to say what would be the expense, but I think from 10*l.* to 15*l.* in addition beyond the common privy; but it depends upon the quantity of the accommodation given in the place before the water-closet is there. If the water is laid on and provided for the use of the house, the water-closet costs less than when the water has to be got from a pump or any other place.

Do you mean that 10*l.* or 15*l.* covers the whole of the expense?—That would be the cost more than the expense of a common privy.

What do you consider the cost of an ordinary privy?—An ordinary privy is little more than a mere building, the case in which it is necessary to put a water-closet; it will depend on circumstances, but the expense would be very small.

Would not such an addition as 10*l.* or 15*l.* for a water-closet add to the rent of every cottage in which it was placed?—I think that if people were obliged to put them, it would be considered as a very severe tax upon them. I think that, generally speaking, the public are not prepared to adopt that course at present, but it is probably leading that way. As for my third-rate houses, I seldom build them without water-closets, and seldom make common privies to them.

Are they self-acting water-closets?—No; but all that are put up for my workmen in the manufactories are; we have water-closets in every place; they are self-acting, but they require a larger quantity of water than the ordinary kind of water-closet.

Will you compare the annual expense of a water-closet with that of a common privy, it being understood that the expense of cleansing a common privy is about 1*l.* per annum?—The expense of the common privy some people would estimate very differently from

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Cubitt.

others; it depends very much upon circumstance, how it is placed; in London there are very few common privies now but which empty themselves, or have the means of emptying themselves, into common sewers. Forty years ago the whole of London received the contents of those places into cesspools in the ground. Latterly they are turned into the sewers, and the river receives them all, or nearly all.

In your view it is not necessary to cleanse the privies, but they would cleanse themselves?—It would require a very careful building for them to cleanse themselves. There is scarcely any privy but would occasionally require some cleansing, but they require comparatively a small quantity of attention.

That cleansing is an additional expense, to be considered as occurring from time to time?—Yes, it is; but every place of that kind will be subject to some expense, even water-closets would not be free from that.

Have you made any comparison of the two?—No; I think that every house ought to have a privy; that every family should have one, but I do not see that that could be made a part of the law.

The making it necessary that every house should have one would lead probably to the substitution of water-closets?—I think as public habits improve and people get more cleanly, they will feel a desire for them. I think the great thing to lead people on to improve their habits is to have the places broad and airy, to let in a great deal of day-light.

The object to be desired would be to substitute water-closets for privies?—That could be done only as the demand for comfort arose.

You state that you would not wish to forbid houses being built back to back, and you have been asked how, if they are to be built back to back, the privies should be managed, and you stated that water-closets may be used; how do you propose to provide places for refuse and ashes?—Generally speaking, a house built in a wide place would have an area, that would be almost a matter of course, and probably a vault under the street, and the areas and vaults are generally found chiefly the receptacles for those things.

You contemplate that either the area or the vault in front, which would be no nuisance to the street, would be the place for the reception of ashes?—I think that would provide for itself, that we need not make provision for it, only to prevent their throwing out things into the street.

The areas and vaults should be cleansed from time to time?—I think the scavenging is a most important part, and it is a very difficult subject, but one that requires to be exceedingly well attended to; it can hardly be too well done; but the difficulty is the expense of keeping every place clean.

If it is your opinion that you should not prohibit houses being

built back to back, would you consider it desirable to enact, that the width of the streets, in the front of houses built back to back, should not be less than a certain width?—They should have only one width; that is, they should not be less than a certain width under any circumstances, and I would leave the rest to work its own course.

You have said that you would not, under any circumstances, have a width for alleys and courts less than that proposed above; what do you consider the minimum width which should be allotted the streets?—30 feet has been the minimum suggested.

Thirty feet for alleys and courts open only at one end, and 20 feet for alleys open at both ends?—I should think no court should be less than 20 feet or 30 feet, and if built on both sides, I would not make it less than 30 feet wide, but I should prefer 40 feet if built on both sides; and I would have every place wide enough for a cart to get in to carry away dirt.

That regulation as to width would apply to all places, whether courts or alleys?—Yes.

With respect to regulations on the subject of cellar dwellings, do you think that there should be some regulation as to the areas, so that the earth should not come against the wall, in the inside of which the cellar dwelling would be?—It would be very important for the comfort of those who occupy such dwellings, but I am afraid of a restriction leading to inconvenience. I am afraid, if by restrictive clauses cellar dwellings are made more healthy than they are now, it will become the fashion to occupy cellars more than at present, and that we should be leading the public to look upon that as a part of a dwelling-house, which is hardly now thought, even in poor neighbourhoods, fit for such a purpose. I would keep the cellars for inferior purposes.

Would it, in your opinion, be desirable to make a distinction as to sleeping places, and to prevent a cellar being used as a sleeping place?—It would be a very good thing if it could be done without great practical inconvenience, but I fear that by making them more wholesome dwelling places we should lead to their being more generally inhabited, that the cellar would be considered as a legitimate part of the house to live in. I would leave the use of it to the option of the person.

Perhaps your view is taken principally from the houses in London. Are you aware that there are 40,000 persons dwelling in cellars in Liverpool, and principally in close parts?—I was not aware of it until I read the Report.

Do you think, that being the case in some towns, some provision is necessary to restrict such habitations?—My fear has always been, that by making the basements better they would be more occupied than they have been hitherto; that would rather tend to increase the occupation of the cellar dwellings.

As that cannot be prevented, would it not be desirable to make

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them more healthy?—It is very difficult to make a cellar a fit place to live in, but it would be very important to make them dry. I should never let the earth touch the walls of the house in any direction. I would let the area go round the house on all sides rather than the ground should touch the walls.

Then an enactment, requiring “an open space or area adjoining to the front, back, or external side of such room or cellar, not less than three feet wide in every part, from six inches below the floor of such room or cellar to the surface or level of the ground,” would in your view tend to make them more healthy?—Decidedly; and I have thought such a restriction was necessary and proper; but on further consideration, I fear it would tend to cellars being very much more occupied than they are at present. I would say that the ground-floor, that is the floor immediately above the basement, should not be less than two feet above the public way, so as to give the basement a little more daylight; but I am afraid, as I said before, of occasioning the basement story to be more occupied. I would never think of making the basement without an area, nor without admitting light, and always making an area all round every part.

If the tendency of such laws would be to increase the occupation of cellars, might it, in your opinion, be desirable, in addition, to provide that in no buildings hereafter to be erected, except on old foundations, cellars should be inhabited?—I think that if a law were made that cellars should not be inhabited, the houses would be built upon the ground, and the upper part of the house would very often be damp; they would not go deep enough to get foundations: it is necessary that the foundation of a house should be low enough on some soils, that the earth on which the house is built should not be subject to the changes of the atmosphere; and when houses are built upon the surface, they often suffer, owing to their foundations being so much exposed.

Have you ever used any material to prevent the extension of damp from below upwards?—In building upon such soils, I generally cover the foundations, that is, after the first two or three courses of bricks, with a course of slate; then I generally lay a course of cement, perhaps two courses.

Is the cement considered impervious to moisture, like slate?—No, it is not so impervious; but it is more so than the mortar.

Have you ever had any experience in the use of asphalte, or a thin layer of pitch, as a substitute for cement, or even for slate, in such cases?—I have used a composition made with tar occasionally for such purposes; but I have generally found that rough or small slate, which will answer the purpose, is much easier to get, and much cheaper than asphalte.

Do you refer to the ordinary asphalte employed in paving?—I supposed the question to refer to the composition of the asphalte as imported, or the artificial asphalte made here, a com-

position of pitch and tar ; but there would be a great difficulty in making that a part of the law ; for many a man who can now manage to build a small cottage for himself would find it difficult to obtain materials of that kind ; and if we threw obstacles in the way, a man who could otherwise build a small cottage might live in a tent, or live as a gipsy.

The question respects the regulations for building in the metropolis. Is it common for persons in the metropolis to build a single house for their own occupation, or is it not usual for all the houses to be built on speculation by builders ?—There are many men who build houses for themselves with very scanty means.

In London ?—Yes, very often. London has been constantly growing ; and there are places in the country which are growing ; and houses are built in the fields, adding them to the town ; and the effect of the Building Act has been to drive such persons to places just past the boundary line. The more restrictive the laws are, the greater difference there will be between the buildings within and without the line, and the effect will be to drive people just outside the line, where they will put up the most obnoxious houses that can be.

Do you not consider that in any situation, such as a large metropolis, where gas-works are so extensively supported, the coal-tar pitch would answer all similar purposes to asphalt ?—Yes ; I have tried that myself, and found it does answer the purpose ; but it is rather a difficult thing for a man working on a small scale to manage.

Supposing such a material were in general use, you do not entertain the opinion that it would be expensive, or that it would be difficult to procure ?—There would be a difficulty to the man that builds a small house, or two or three houses ; for he would require a certain apparatus for heating it, and it would take up his time and attention ; and being a thing he was not used to, he would be afraid of the risk, and he would feel it a hardship to be obliged to use it. It is not at all uncommon, when ground is laid out to form a new street, for a man to come and take a small plot and to build his house singly, engaging for the building of it. That house forms one of a row ; but out of a row of ten houses there may be six, or eight, or ten proprietors.

Have you ever turned your attention at all to the inquiry as to where the numbers of the poorer classes who are dislodged from certain localities by the progress of improvements in this town, remove to ; for instance, whither those who are at this moment removing from Whitechapel and St. Giles's are about to migrate ?—I think they try to make towards the outside of the town, where the small houses are generally built.

Do they build new houses, or do they go to parts where houses are already built ?—There are very few poor persons who are turned out who can provide a new house ; in consequence of that

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they probably seek other houses already prepared for them. It would be very difficult, I think, to say how they are disposed of; but the improvement of a large district tends to raise the rents of the small houses near that part, and it drives the people a little farther off, farther towards the edges of the town.

You have stated that you think certain regulations in respect of the width of streets and alleys are necessary for the health of the humbler classes, but that if those regulations extend only to a particular district, that has the effect of driving persons to worse habitations, just beyond the district?—Yes; and a very much worse kind of place is provided, where there are no regulations; that would have been attempted in the other districts but for the severe restrictions.

Does not that show the necessity of making such regulations, when duly and properly considered, for the advantage of the people in general?—It appears to me to be very difficult to know where the limits of any restrictive laws should stop. I think it is most probable that, when this Bill passes, there will be accommodation provided for very poor people upon wet soils, perhaps in very low and damp situations, where there is no drainage and very bad circulation of air, just outside of the lines, where they will be stowed very close together in very damp and very filthy places.

Do you conceive that it would be possible to induce the present inhabitants of St. Giles's, for instance, to go so far off from their daily occupations as the limits that have been proposed in a Bill now before Parliament?—Persons would not migrate in large bodies, but they would get their accommodation as near as they can to their work; and many poor people have to go three or four miles; many of my workmen live at the distance of four or five miles from their work. I would rather see a very extended line, within so many miles from the Post-office, or a given spot in London; but it ought to be a very extended line; I am not prepared to say to what extent, but I think it ought to be extended very much farther than it is at present. The boundaries of parishes form exceedingly irregular lines; some of the boundaries at present are very much nearer London than others, and so they would be under the proposed Bill. With regard to building small houses, I think the restrictions ought to be very much less stringent as to heights. I think it is very desirable that the small houses should not be of necessity low houses. I should like them to be able to have them four stories high, that is, four stories fit to live in; for if they are very low they have more trouble with their filth, the smoke hangs about, and they are more dirty and ill-aired, their height not giving sufficient current for the air to ascend. I would not limit them so much even as the present law does.

What height should you give to each story?—I should like the smallest kind of house which is constructed, at least four stories above the ground. I would let them build the stories of any height they like.

Supposing there was no limitation as to height, would not they put in three stories in the place of two, and make the stories proportionably shallow, in order to save expense?—I would not restrict them to less than four stories above the ground, the smallest class of house; but I would let them build those stories of any height they like.

In such houses would there be an opportunity for introducing one spare flue?—There would be an opportunity.

Would that add much to the expense?—Not much, if they were not restricted too severely in the manner of building those flues. My own opinion is, that the party-wall with flues, according to the present Act, is sufficiently stringent, taking care not to have any combustible material in the wall; but our experience seems to show that we have had very few accidents of a building falling down, and we scarcely ever hear of such a thing as a fire extending, in a house built under the present Building Act, beyond the house in which it originated; it does not appear necessary, therefore, to have the party-walls thicker than at present. I should like a law to oblige every house above a certain class to have its own walls. I should be glad even to be obliged to build all my first and second-rate houses with separate walls instead of party-walls; but I think the passing such a law would be considered very oppressive: but it would be a great advantage to the houses, and add greatly to the comfort of the inhabitants if it were so.

Can you inform the Commissioners whether the dust-bins generally discharge a very offensive odour?—I think they would be very likely to do so at this particular time, when vegetables are in great abundance, and the weather very damp. My feeling about the width of streets is greatly influenced by a desire to clear away all that nuisance and rubbish which accumulates from day to day with greater ease than at present; and if the streets were wider, then they might get them cleared of the dust more easily. It would not accumulate as it does, if it became the habit to clear it away. The more cleanly the people become, the more anxious they are to derive the advantage of it; and it appears to me that people become, by living in a very dirty place, very much degraded; and on the other hand they improve if the place is kept clean about them. I feel it of great consequence to give them every possible means of clearing away rubbish. I think it is of the greatest consequence that the public authorities should have the public pavement and the public roads well attended to; and the scavenging of London, though better attended to than in most places, is not anything like so well done as it ought to be.

Would it be objectionable to conduct a discharge of air from the dust-bin into the spare flue to which reference was made, so as to occasion a constant effusion of the deleterious air?—I think that would not be difficult; I think that if a Board of this kind were to be permanent, it would be very well if the Board were to have

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models and plans occasionally published, and cheap hints that would enable people to do many things for themselves, and that the improvements would go on much faster than if they were compelled to do this or the other; that if this Board were constantly getting information, and publishing cheap tracts and wood-cuts, and exhibiting models, or if models of cheap accommodation for the people could be shown occasionally in some places, where the public might get to them, in the same manner as articles are at the museums, a few hundred pounds spent in that way would have a very beneficial effect; for the poorer classes, in order to their seeking proper accommodations, should see those things exhibited.

Have you ever had your attention directed to some plans proposed lately for dispensing with the use of water for closets, and yet at the same time ensuring as effectual a removal of their contents, by means of a mixture intended principally to economize materials for manure and agricultural purposes?—I should be afraid of recommending to any of the poor any other mode of cleansing than with a large quantity of water; I would give every possible facility to the water-companies to induce them to give a large supply, and I think I should go to this extent; I should like some sort of understanding to take place, that if any new bills for water-companies were brought in, it should be one of the obligations that their mains should be always filled, and people living in any house should always be able to get it from the mains.

That they should be allowed to draw off any quantity they wished?—Yes; I think that would tend very greatly to the improvement of London.

Do not you consider it an objectionable thing in itself that so much material should be swept into the river uselessly, if it could be avoided?—With respect to sewage, it appears to me that the whole material, we may say, that is consumed in London is all swept away, or nearly so, by the river, and that there must be quantity enough every week swept away to fertilize a vast number of acres of land, if made productive; but I do not think that the present state of our knowledge will enable us to use it with economy, or that we can lay down any plan at present for collecting it, although I should like to see it taken away from the towns as fast as possible. I regret very much that we should carry our drainage into the part of the Thames we do; I regret that something is not done to enable us to carry the foul matter all away from London.

You would be glad to see any practicable method by which the refuse of the town should be carried out into the country?—I should; and I think the best way of furnishing the means for that would be to carry it further off from the town, and not into the upper part of the river, but to carry it further before the discharge mixes with the river.

You have not considered any of the plans which have been

spoken of, for carrying away the impurities of water to a distance, so as to fertilize the districts in the neighbourhood of populous cities?—I have thought a great deal about them, but I am not aware of any plan which could be worked out so as to make it economical.

If it could be removed consistently with economy, you would consider that a great object was attained?—Certainly.

In looking at the condition of the habitations of the poor in London, would you consider it desirable that arrangements should be made, especially where houses were very densely populated, for enabling washing to be conducted at a low rate in public buildings, to which families might have access?—I thought for some years of my life that it would be a very good thing in all towns if means were furnished and places provided for the poor to wash and do many of their dirty works in; but further consideration induces me to suppose it is better not to mix the families together; that the evil would preponderate over the good; and I would rather leave them to seek accommodation, so as to do all the work in their own habitations, than mix them in one building. I would not promote their mixing together in common; there are generally evil results from it.

For the discharge of the air from the kitchens, and from washing, in houses of different descriptions, would it not be desirable to have one large and central flue, of a sufficient size to secure the direct discharge of vitiated air in the lower apartments, without passing through the rooms above?—I think the time will come when every good house will be ventilated in such a way as is now done in the Houses of Parliament; but I think it would take some time to lead the public to that.

Without leading the public to such extensive arrangements as are adopted there, and meeting peculiar contingencies, would it not be important to introduce the use of flues for the discharge of offensive air, as is frequently found in small houses on a washing-day?—No doubt it would be a good thing that every basement, and every privy or water-closet, should be furnished with a ventilating flue, going as high as the upper part of the house, a flue built purposely for that object; but I think it would be very irksome if they were required to do that in the stringent way that the proposed new Building Act contemplates; that is, that every flue should be of a certain size and thickness. It would be so expensive that it would rather retard than invite improved building.

You think it would be better to have the advantage of it put forward by its being known and understood than by law compelling it?—I think it would work faster, and they would go more cheerfully to it.

Is there a publication on the best structure of houses for the humbler classes of persons in large towns, pointing out the best and cheapest mode of construction, with the modern improvements

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for their health and comfort, and with reference to the supply of water and those other conveniences which experience of late days has shown to be necessary?—There are many publications referring to those points. I think that probably Loudon, the landscape gardener, has done more than any other, in his “Cottage Architecture.”

That is rather referable to rural dwellings?—I do not recollect anything for towns particularly.

Do you not think it would be advantageous if, either by means of a premium, or by means of public Boards, or by holding out an inducement, the attention of architects and other persons were attracted to such a subject, with a view to throw into the structure of the dwellings of the humbler classes those improvements which have been devised lately with reference to other classes?—All the builders and architects in London have their eyes constantly open to take advantage of every new material, and every new application of that material, and of every adaptation of a building which should give more for the money or make the thing better. I think that suggestions by which a poor person’s house might be improved without much increased expense, from time to time, not enforced by law, would be very desirable; taking advantage of a new application of a material from time to time, or a new material. If specimens of those things were put before the public from time to time, the improvements would work much faster than where the public are left to find out those things for themselves.

With the facility of communication to those in the habit of building, any improvement in one part of the country would be immediately brought to bear on another part of the country?—It would be so; but there are parts of London where the small buildings are very inferior to others, even in the same district; but I think if persons understood that they could see improvements from time to time, at any fixed place or public exhibition, in a cheap form, adapted for use among the poor, great advantage would be taken of those things; but with regard to material, it is difficult to form a law, as we are constantly changing our material; for instance, much more iron is used now than formerly, and it would be desirable to encourage the use of iron, but I do not think it would be prudent to attempt to do it by law.

In your view, the intelligence and experience of builders, supported by self-interest, would do more to promote improvements in building than any compulsory law?—I think that what should be done by law should be to prevent a person injuring his neighbour, and that it would be desirable to have the houses rather high than low, and to take care that there is a very easy access to them, leaving much of the rest to regulate itself.

Do you think it would be practicable that the district surveyor, to whom a builder might go to get his levels, should be required to give information of the kind you mention?—No; I think

the information should be established at some one central point, and where the whole of it should be seen by large drawings, or by models; and with regard to the levels of sewers, or things of that sort, I think there is no difficulty at present in knowing the mode of drainage of any part of any neighbourhood of the metropolis, by applying at the present sewer offices. I think it is very objectionable allotting the duty to district surveyors for looking to those things; what I would require by law is, that there should be positive means of draining every part; and I think that there is no need of interference with persons' drains if the means of discharge are provided.

You state that you think a certain area, or a certain width of court, is necessary for the houses of the humbler classes, to give them air. Are there other conditions necessary for their well-being; a certain facility of drainage you would consider necessary?—I would not allow a house to be built at all unless there were positive means of draining it; they should be sure there was a drain, or some kind of accommodation for drainage or sewage.

Do you consider the supply of water to the houses, for the use of the humbler classes, of importance to their comfort?—I think it of the greatest importance.

Do you consider that the cleansing of filth and refuse from them is also important to their health?—I think it of the greatest importance; but it would be very difficult to enforce on a person the cleansing the inside of his house. I think if easy means are given for a cart getting to the places, the desire for getting the stuff, on the part of the collectors, might be made sufficient to ensure their going for it; and that if the people themselves knew that it would be regularly taken, they would be eager to get rid of it. I think that where the scavengers can go, there is no great deposit generally of filth at present.

Your view is, that there should be a free circulation of air in front of the houses, by means of sufficient width of street, a good drainage and sewage, a proper clearing away of the dirt and filth by means of scavengers, and a good supply of water?—Yes; I think those things should be positively provided for; that it should be the duty of some public authorities to see that done.

With respect to the water-rates, have you turned your attention to the question on whom that rate ought to be made, whether upon the owner or the occupier, or in any given proportions between them?—I do not think it is of much consequence who pays the rate; the companies themselves make their arrangements for that; probably it would be a good thing if every person who offers a house to let should not be permitted to receive any rent unless there was a supply of water.

In some way you would enforce a good supply of water for the

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poorer classes?——Yes, I should wish the supply of water to be much more extended than it is at present. The expense of a water company consists not so much in what may be called their plant, that is, their buildings and pumping machinery, as the capital required for carrying the pipes everywhere. Those companies have many hundred miles of pipes, and it is there that much of their capital is locked up. It would not greatly increase their expenditure if they pumped up a much greater quantity; the expense would not be in the same proportion; and the supply of London is unlimited. But I would like to make the Thames cleaner, as that is the great source of supply.

Do you consider the following to be a fair estimate of the cost of a water-closet?——

ESTIMATE by Mr. HOWELL of the Cost of structural Arrangements of Sewerage, Drainage, Water-tank, and means of House-cleansing for Labourers' Tenements in the Metropolis:—

Feet.	£	s.	d.
55 Drain and digging, with pantile bottom, three courses high, arched over and cemented	4	2	6
10 Small drain for water-pipe	0	10	0
46 Sup. slate slab cistern, 4 ft. by 3 ft. 9, and 2 ft. deep, holding 150 gallons	4	12	0
62 Three-quarter pipe, to serve cistern, including joints and fixing	3	2	0
— Ditto, ditto yard ditto	0	12	0
— Two three-quarter cocks, 10s. ; one cock-ball and boss, 8s.	0	18	0
7 Inch standing and under waste	0	10	6
1¼ washer and waste	0	2	6
Pan closet, with basin, &c., complete	3	10	0
Strong D trap, 20s. ; service-box, 10s. 6d.	1	10	6
Cover to cistern	0	15	0
	20	5	0
Deduct 7½ per cent. if done at contract prices	1	10	0
	18	15	0

From the above estimate the following items should be deducted, as appertaining to the present objectionable system:—

	£.	s.	d.
Cesspool	1	0	0
Roof of privy and ceiling	0	15	0
Drain, say 65 feet	3	5	0
Water-butt and stand	1	5	0
Service-pipe, 40 feet	2	0	0
Cock and ball, 8s. ; waste-pipe, 7s.	0	15	0
	8	6	6
Less 7½ per cent.	0	13	6
	8	6	6
	£10	8	6

It does not seem far out, but I have not time to examine it. Speaking of the dense population, I would suggest, the broad streets would make the population much less dense than if they were not so restricted; but I think that the great thing that is necessary is to give all the people more cleanly habits. One of the

great difficulties of being cleanly in and about London is the great quantity of black matter constantly floating about in the air. If persons come out from a country district, when they come first to London they have frequently very cleanly habits; the women are very careful about their linen when they first come to London. A man coming with his family from a country district have their linen much more nice than after they have been in town longer; they have been more accustomed to a clearer atmosphere, and their habits are better; but after they have been some time here, they feel that they cannot conquer their difficulties with the dirt, and they yield to circumstances. It appears to me of greater consequence to remove a great many of the great public nuisances than it is to restrict their own dwellings so much; that if we gave them a better atmosphere, we should keep their minds in a better state, and that they themselves would be much more desirous of preserving neatness than they are at present: those who wish to be cleanly, are depressed by the difficulty there is in being so. It appears to me that the first thing that ought to be done is to prevent the great smoke of chimneys; that ought to be stopped. My own opinion is, that if a law were passed to prevent any smoke passing out of a chimney, more than ought to pass out of an ordinary kitchen fire-place, and if every person were obliged to keep his smoke within that limit, in a very short time there would be no difficulty in enforcing it, and that the means would be very soon found. I am not supposing but that it would not cost the persons a little more to do it, but the public must pay for that; for all these great manufactories are furnishing something for the public use generally. No one brewer or distiller will like to do that which he is not compelled to do, because his neighbours will not do it. A great number of works are giving out great volumes of smoke; the great public breweries and distilleries are all doing the same. If you go to the top of this building you will see within half a mile many large chimneys vomiting forth black matter; all those tend to destroy the property of the rich as well as the poor—the gentleman living in a good house; able to provide, and desirous of having the best furniture that can be procured. Take, for instance, some of the best houses which can be found in London, the depreciation caused by the injury of the black atmosphere goes on very fast, and tends to depress the feeling for keeping up those things, and to prevent the encouragement of the finer class of workmen; and it prevents the houses being so nicely fitted up, because they cannot be kept in a satisfactory state. People are less willing to have expensive paper-hanging, and nice painting, and nice upholstery, because everything gets so black in London. If we could induce persons to be more desirous of having those things in better order, we should furnish the means of employment for a great number of persons who are not so well occupied now,

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You consider that it is injurious to trade as well as to health? —Yes; I think the injury to trade is far beyond one's conception at the first glance of the thing.

You think it would be quite practicable to prevent it?—I think our atmosphere need not be half so bad as it is.

Suppose those manufacturers were compelled, at a small additional expense, to prevent this thick smoke arising; the probability is they would charge a little more on the article they produced, and thereby the public would have to pay a little more in that way; but they would, in your opinion, gain the advantage?—I think the public might pay a little more for some things, but it would be fully compensated by the advantage they would receive; it would apply to the furniture and clothing, and nearly every article of use, which would have a higher value from being clean, and this would induce persons to get a better kind of accommodation. I think that the furnishing easy means for them to be clean would be very much better than making restrictions or requiring it by law. I employ a steam-engine and there is no neighbourhood in which there are not steam-engines; but there is no great encouragement for any one person to do away with his smoke, because his neighbours do not do so; each says, "I must render my article as cheap as that of my neighbours." But there is another thing which requires attention; that is, to do away with all the offensive chemical works from London: I think there is a great deal of destructive effect on the health of the metropolis occasioned by them.

Are you aware that it has been proposed to permit the continuance of certain noxious trades for 30 years, then they are only to be carried on under certain restrictions?—Thirty years appear to me to be beyond all useful limit, for within 30 years nearly all the present race will cease to exist; but it appears to me that if they are offensive they ought to be removed in seven years at the furthest. I should think that many of them should be limited to two or three.

You would introduce a stringent measure, to be carried into effect without delay?—Yes. I think there would probably be a great outcry on the part of the manufacturers, but there would be very little hardship in its real effect as it worked. Take the great gas-works: I should say they ought to be removed quite out of the limits of London; and if you took any one of those separately or singly, it would be a great hardship; but if the whole were forced to remove, it would be very little loss, as they are not bound to supply their article at any particular price, except perhaps for short periods of contracts; place them on the same footing, they would furnish their gas at a higher rate. But suppose the public paid more, they would want less of it, because the atmosphere would be better.

You would make an efficient law to remove nuisances to health?

—I think the law respecting the removal of nuisances injurious to health can hardly be made stringent enough; and that it ought not to be the duty of an officer paid by fees, but that it should be the duty of a public officer, the same as it is the duty of the Attorney-General to prosecute a libel upon the Government. It would not require the interference of a great many; the nuisance would be very soon discovered and put down, if they had a very strong Act. They should have such a salary as would make them above being corrupted; and they should be public officers, appointed for the purpose only.

In your own experience, do you know that nuisances are produced from factories, of an extremely disgusting nature?—There are manufactures carried on by the side of the Thames; and I am quite certain that if the gentlemen present were to go up or down the river, between London and Battersea Bridges, they could not avoid having the subject forced upon them. I have it at times forced upon me. I have at times been passing Battersea, as well as Chelsea, where the effluvia from the works is extremely offensive; and I think it must be extremely injudicious to health; indeed, I feel that the effect is painful, as well as injurious and destructive to health.

Do you refer to gas-works?—Yes, and to chemical works, vitriol works, and such things.

Do you not consider that the chemical evidence, in cases of proceedings against those works, is not sufficiently investigated?—I think that the proceeding by an indictment, according to the present law, is extremely doubtful and difficult to manage; and persons who are carrying on a profitable manufactory, though at the same time a very offensive one, generally manage to carry it on in spite of the law, because, if it is a very profitable object, they have no great difficulty in getting that kind of evidence which satisfies or embarrasses the minds of the jury; for there is no difficulty to get chemical evidence, and to produce any kind of proof they want, or to get professional men of any kind to give any evidence to prove that the most noxious things are harmless; and, therefore, I say there ought to be a public officer to take measures to put those nuisances down, and that such officer should be so paid as to be above corruption.

You are of opinion that, if means are afforded for promoting personal cleanliness and general cleanliness, the poor would be induced to avail themselves of any means of thus advancing their comfort?—I think that if you could give them the means of advancement a little in that, and induce them to take the first step, they would soon rise two or three more steps of themselves. Poor men and rich men are all of the same material, and their minds are working to nearly the same points. One of the greatest improvements of London would be to get the people all well employed; and I do not know anything that would do more for

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labouring classes, and in proportion for those above them, than to give to the rich people the power of having their houses very nice, as it would induce them to spend more money. I think it would encourage the fine arts to a very great extent, and encourage all the better kind of manufactures, and thus produce a general benefit.

MR. HUGH BIERSE, examined.

Mr. Hugh Biers. **THE** Commissioners understand that you have had very considerable experience in the construction of sewers, as well as in building operations generally?—I have been very largely engaged in the sewage of the north-western district of the metropolis, from 1823 up to the present time; and I think that the evil of the present sewage is, that it is much too expensive a method of draining, especially of the smaller description of houses.

In what capacity have you been placed, so as to have your attention called to the subject?—As a builder. I have built very largely on Lord Portman's estate, on the Bishop of London's estate, and others, both where there are good houses, and where there is a smaller description of dwellings for the poor.

In what district of sewers?—I have principally built sewers in the Westminster district, and I have often endeavoured to impress upon the Commissioners of that district that there ought to be a smaller description of sewer than the smallest size they now permit. In a great number of instances, instead of the building of sewers being promoted, it is evaded, in consequence of the expense.

Can you inform the Commissioners what are the rules and regulations the Commissioners impose on the builders?—There are two sized sewers, a large one and a small one; the difference in the expense respectively is not a great deal. A person wishing to build a sewer has to apply to the Commissioners, who decide whether the sewer is to be a large one or one of the smaller size. The applicant builds it at his own expense, under the superintendence of one of the clerks of the Commissioners, along the fronts of his houses, and he then has to make a drain from each house to that sewer.

What are the sizes of the sewers, and how are the houses drained by such sewers?—The one is 5 feet high by 2 feet 6 wide, and the other is 5 feet 6 by 3 feet; then from each of the houses whose frontage run parallel with that sewer, a drain must be built; part of that drain the Commissioners put in themselves at the expense of the builders. I have endeavoured to impress upon the Commissioners that the builder ought to be permitted to put this drain in himself, but never with any effect; and the reason I have done so is, that they charge a much greater sum for doing it than it would cost the builder; so that there is not only in many instances a much larger sewer than is necessary, but there is an

additional expense of employing the contractor of the Com- Mr. Hugh Biers.
missioners.

Who constructs the main sewer?—All new sewers are built by the builder of the houses. He builds it under the direction of the Commissioners, without any cost to the Commission beyond the superintendence.

The Commissioners insist upon their own contractor building part of the drain connected with the house; do they charge anything for that?—For three feet of the drain, and entering a ring into the sewer, the Commissioners, for a 12-inch drain, charge 1*l.* 3*s.*; the builder could do it well for 10*s.* or 11*s.* In my opinion, if the Commissioners insist upon doing that work, they ought at all events to do it for the price the builder can do the work for himself.

How much of that 1*l.* 3*s.* is for the building, and how much for fees?—There are no fees now in the Westminster district; the whole amount, I have no doubt, is paid to the contractor; nor do I think the contractor is at all overpaid; for instead of the builder, who is on the spot doing it, the contractor has to send the men, perhaps from a distance, and a cart and horse with the materials; thus a great deal of time is wasted. This extra charge for waste of time, in my opinion, ought not to be borne by the builder. Nor is this the only inconvenience the builder is obliged to submit to by this rule of the Commissioners: it will sometimes happen that the contractor's men cannot attend at the time appointed; the ground will then sometimes colt in, and another expense is incurred for taking it out. It once occurred to me that the contractor's men not having attended the appointment, a rainy night threw a large quantity of earth into the excavation, and with it a part of a turnpike; this caused a very considerable addition to the charges for putting in this drain, and had very nearly, from the loose nature of the ground, caused a complete stoppage in one of the main roads out of London; and in a very recent case an appointment was made to enter the drain on a Saturday afternoon: the materials were sent, but no men came; after waiting until late in the evening, the excavation had to be filled in again. On Monday the ground was again taken out, but no Commissioners' men made their appearance; the excavation had then to be lighted and watched all night; on Tuesday the ring and drain were put in. All this might have been avoided, and all this expense saved, had I been permitted to have put in the ring and built this three feet of drain, and which, having built many miles of sewers, I considered I was as well qualified to do as the contractor.

The builder constructs the sewer; but the contractor constructs three feet of the drain to the sewer?—Yes; and the ring in the sewer besides.

For what purpose do the Commissioners insist upon executing that particular portion of the work?—I suppose they think they

Mr. Hugh Biers. can depend upon their own workmen doing it better than an individual builder.

Is that junction of more importance than the construction of the sewer itself? —No; it is only cutting away and making good the springing wall to the ring that is of any importance.

Do they have to keep it in repair afterwards? —After the sewer is taken to by the Commissioners they keep the sewer in repair, but not the drain.

You stated that they insist upon a drain being made to each house. Is that to each house of every class, or only houses of particular classes? —Each house of every class, even the smallest, if it has a drain, must have a separate one, but I should not object to that regulation, if properly carried out.

Do you mean that they insist on a drain being made to every house? —The Commissioners have not the power to compel any person to communicate with the sewer, but they will not allow two houses to drain through one drain if they know it. I now refer to the Westminster sewers: there are other Commissioners that will not permit less than three houses to be drained by one drain.

For what purpose is the regulation which insists upon separate drains? —In the first place, that the builder of the sewer may obtain payment for the sewage in frontage of a line not wholly in his possession; and, secondly, to prevent a surreptitious drainage from other houses that have not contributed to the expense of building the sewer.

Do not all the houses pay to the drainage? —Being a sewer builder to a very large extent, I have often persons to deal with who contrive to obtain a surreptitious drainage. To avoid the present charges, which I admit to be exceedingly heavy, and often much too large, especially for the poorer class of houses, they will sometimes give a neighbour, who has paid, a trifle to permit a communication through his drain; and they will often do without a drain at all. All rated houses pay to the sewer-rate, whether drained or not, but the building the sewer is a distinct and separate charge upon the building. I have at least 1000*l.* laid out in sewers, of which I dare say I shall never see a quarter, in consequence of this surreptitious mode of getting a drainage. I can mention one case that lately occurred where a person had for thirteen years drained three houses through one drain, having only paid for one house; he was found out, and then paid me for the other two. In another instance the cost of a sewer built abutting upon the front and flank of a house amounted to nearly the value of the house itself (it being one of the smaller description of buildings). For this sewer I have never been paid, nor do I suppose I ever shall be.

You state that the sewers are in a number of places much larger than necessary? —Decidedly; there should be a smaller sized sewer for the poorer description of houses, which would be

sufficient for the upper drainage, where the sewer would not be further extended. I built in the Edgware-road five houses, the sewage for which cost me nearly 500*l*. This extravagant sized sewer is entered by an 18-inch barrel-drain, through which upwards of forty houses have been drained for the last twenty years, and there never has been any stoppage of the least importance. I had reason to expect that if this large sewer was built I should be repaid a moiety of the expense; but after the sewer was built the Commissioners found that they could not compel the owners on the opposite side to break up their old drainage and adopt the new; so there the sewer now remains, either as a charge upon the houses or a loss to myself.

Mr. Hugh Biers.

Of what size would you recommend the smaller description of drain?—If it was to drain the roadway, and the houses on each side of the roadway, half the area of the present Westminster small sewer would be sufficient.

Do you state that, looking to the possibility of an extension?—No; I refer to a branch-sewer only. The main sewers require to be nearly the size they are at present; made 5 feet by 2 feet 6 inches.

You say that an 18-inch barrel-drain drained 40 or 50 houses. Has that had any particular advantage of being flushed with water?—All the water that is used in the houses passes through it.

Are those houses supplied with water?—Yes.

Therefore there is the advantage of the supply of water used in 40 or 50 houses to keep it clear?—Yes.

You would say that an 18-inch barrel-drain would be sufficient for 40 or 50 houses?—Yes, it would be quite sufficient for 200 or 300 yards in the upper part of a line of sewer.

With what fall?—It would depend upon the facility afforded by the ground.

What fall has that 18-inch barrel-drain?—That has a very good fall, perhaps an inch and a half to 10 feet, and in places perhaps more than that.

What is the least fall which you would consider necessary for an efficient drainage?—I have put sewage in at as slight a current as half an inch to 10 feet, where the depth of digging was such that it could not be more.

You would consider that that was a sufficient drainage?—Not if I could get better.

Do you think it would be sufficient for an 18-inch barrel-drain?—It depends a great deal upon a plentiful supply of water; in fact it all depends upon the supply of water.

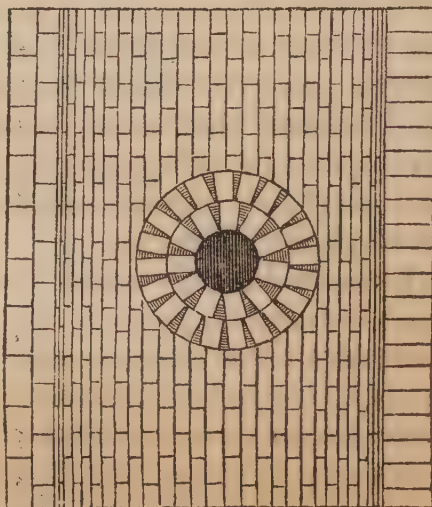
What is the average expense of constructing sewers of the largest description mentioned by you?—About a guinea a lineal foot; a little more or less, according to the depth of digging, &c.

What would be the expense of the second class?—The second class is two or three shillings per foot less.

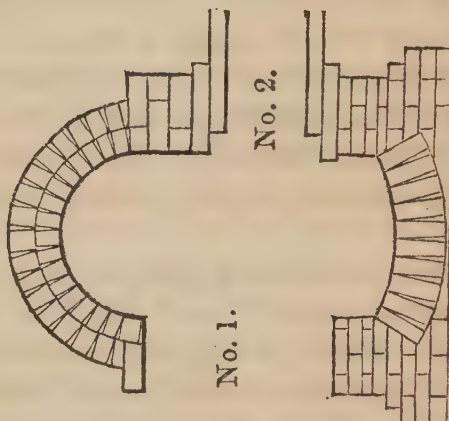
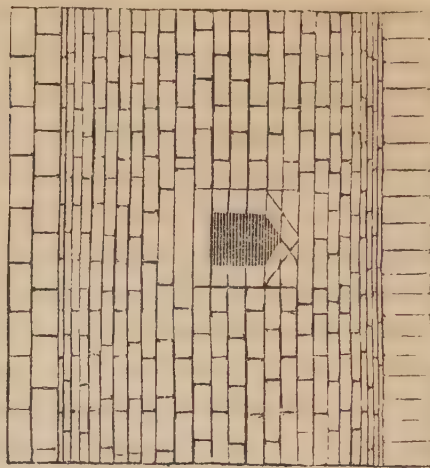
Mr. Hugh Biers.

No. 1.—WESTMINSTER SEWERS.

Method of entering sewers under the Westminster Commission, showing the great extent of surface in the springing walls necessary to be cut away at each insertion, thereby greatly damaging the stability of the sewer.

No. 1.

Section showing the difference in the cutting away the springing walls if the drain-plan No. 2 was adopted.

No. 2.**No. 3.**

Proposed method of entering the sewers by which but a comparatively small portion of the springing wall is cut away, and the usual bond of the brickwork is retained.

The Commissioners of Sewers charge for the entry into the sewer, and 3 feet of 12-inch drain, 1*l.* 3*s.* Added to this the expense of lighting and watching, and other incidental expenses incurred by the builder. If the builder was permitted to do the work the cost to him would not be more than 10*s.* or 11*s.*

What would you estimate the expense of the third class of sewer you would recommend to be adopted?—Somewhere about 10s.; or less even than that. Mr. Hugh Biers.

What size would that be?—Half the area of the other.

What form do you consider to be the best for the construction of the largest class of sewers?—There are two or three considerations as to the proper construction of a sewer: first, as to the strength of its structure; secondly, as to its formation for properly economizing the water passing through it. As bricks are at present made, being square, there is hardly a weaker construction, in my opinion, than a small barrel-drain; and every construction approaching a circle must more or less partake of this weakness. The intradoes of the joints of the drain are close, the extradoes are made up with mortar. I have used bricks which have been made purposely for drains, but they come very expensive; I therefore prefer square drains.

What is the average expense of the bricks per thousand of which you make the square drains?—From 36s. to 40s.

What would be the expense of the bricks you describe as having been made specially?—I think I paid 2l. 15s. for them.

Of what form have you constructed the sewers you have built?—According to the section set out by the Westminster sewers. I have here a drawing made for the purpose of showing the ill effects of putting such large rings into the springing walls. (See p. 284.)

Do you consider this form a good one for giving full effect to the water in cleansing the sewer?—I think if the invert was a quicker sweep it would be better as regards the natural or self-cleansing. I have seen the Finsbury sewers, and I think they are very well adapted for carrying off the water.

Do you consider the form of the Finsbury sewer, as regards the cleansing, better than that of the Westminster?—I think it is the quicker sweep, having a tendency to collect the sullage into a smaller space, and consequently the water has more power; but this form has still the objection that while the inside of the invert may be brick, the extrado of the joint is of considerable thickness in mortar; and when once the inside face of the invert begins to wear away, I am of opinion that a very rapid decay will take place, from the surface presenting a soft instead of a solid material.

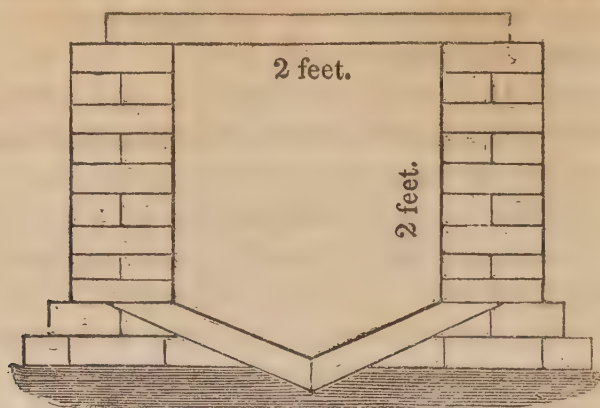
It is much less likely to become choked up?—As regards form, I think it is likely to choke up.

It would be a cheaper sewer to build, having less materials in it?—Yes; it is decidedly cheaper.

The outside wall might then be a brick, instead of a brick and a half?—Yes; and that in my opinion would be quite sufficient in almost all sewers, except the main lines; and I beg to submit a drawing of a sewer quite sufficient for an upper drainage to 20 or 30 houses.

Mr. Hugh Biers.

No. 4.—Section of a Sewer for Surface or Upper Drainage



At 6 feet depth of digging this sewer will cost 7s. per foot lineal. For every additional course in depth add 10d. per foot lineal.

Do you use any particular kind of mortar or cement?—Stone lime and river sand is always used.

Are you satisfied that the nature of the mortar is sufficiently adhesive for those purposes?—Yes; quite so.

Are you aware whether it becomes porous in the course of time, and discharges water from that cause?—I never knew of an escape of water through the brickwork or sides of a sewer.

In your experience they are water-tight?—So completely that if a sewer is constructed with proper materials, hard stock-bricks, and good stone lime and river sand, the cutting away to put in the ring from the drain to the sewer is sometimes found to be a work of some difficulty, and it gets much stronger by time.

Do you find the same with respect to the small barrel-drain?—Yes; they, as well as the sewers, become in time to be what is termed water-bound.

They equally become water-tight?—Yes; but the smaller the drain the worse the joint is, being a circle.

Do those small drains ever leak; does the earth outside become saturated with the contents of the drain?—I have seldom found that to be the case.

You have tried that so frequently as to know that it is not the case?—It never has been in my experience, unless there has been a *stoppage* of the drain, and that stoppage must have continued for a very considerable period.

Have you frequent opportunities of observing whether there is exudation?—I have had frequent opportunities of taking up drains and repairing them; but I have seldom found it in those properly constructed.

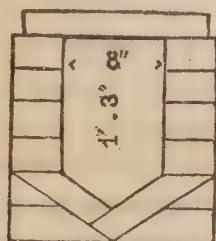
Are they so constructed that that often does take place?—Sometimes there may be a faulty brick, or the workman may have been careless in the construction of the drain, then it may possibly leak at the side, but seldom anything of very great importance.

Then from faulty bricks or careless workmen those drains do

occasionally exude?—There may be instances, but I am not Mr. Hugh Biers.
aware of any of importance; the drains are generally efficient.

What are the advantages you propose by this new form of drain shown in the drawing?—Strength and durability with the same inside area as a 12-inch barrel-drain, and without additional cost.

No. 5.



How do you propose to effect that in a 12-inch barrel-drain? —I do not mean a 12-inch barrel-drain at all; the form I would propose would be as No. 4 in the drawing.

To what size would you be able to restrict that?—The area is the same as that of a 12-inch barrel-drain.

Would you make the drain the same form the whole length? —If I had my own will in the construction of a drain, I should carry that drain right through the house.

What would be the effect of the discharge of water through that drain as respects the shape of the bottom?—All the sullage must fall to the centre, and the water passing through the drain would, by its concentration, have greater power in expelling such sullage.

You consider an acute angle at the bottom better than the segment of a circle?—I do so; and the more especially as the segment of a circle in stone would make it very expensive.

Do you speak from experience or from theory?—I speak from experience; and where I am not bound by a covenant to construct a barrel-drain, I invariably build one similar to this. In a barrel-drain, a very great portion of the outside is mortar; in this you have nothing but the hard material.

The question refers to the angular point at the bottom?—The more you can collect the water into the centre of either a drain or sewer, the less liable will be a stoppage.

Have you built this drain to any extent?—Only to my own private buildings.

What is the actual cost per foot run of a 12-inch barrel-drain? —A 12-inch barrel-drain will cost about 2*s.* per foot run.

Do the Commissioners of Sewers insist that the drains from each house shall be of a particular size?—No; there are two sizes, 9 or 12 inches.

Do they fix the minimum?—Yes; 9 inches is the minimum.

Do they fix the maximum?—No; I have put them in as large as 18 inches where the drainage required it.

Mr. Hugh Biers. For a first-class house, what should you put?—An area of 112 superficial inches is quite sufficient for any private house.

You have constructed drains for a continuation of houses?—Yes.

What is the size of those?—Generally a 9-inch barrel-drain; but I prefer square drains where the covenant in the building articles does not compel a barrel-drain. I much prefer the form of the drain No. 5.

The least which is usual to put in is nine inches, that is, nine inches communicating from the house to the sewer?—A drain having an area of about 60 superficial inches is, generally speaking, quite sufficient for almost any private dwelling.

For the smaller classes of houses is it necessary to have them as large as that?—I should say from the house to the sewer there ought to be an area of 60 inches; but in the interior, less will very often do.

Is it on any experience you state, that you find it to be necessary to have a 9-inch drain, and that a 6-inch would not do for the outside of the house?—I think a smaller one would do in many cases; but the difference of expense, after you get out of the house, is not worth saving, and the larger size might perhaps sometimes prevent the taking up the road-way, paving, &c.

If it could be shown that the smaller could be made much cheaper, should not you come to the conclusion that it would be desirable to put smaller?—Decidedly; but I do not think you can show a very great saving.

If they are made of brick, making them smaller would be a very little saving?—Very little.

If they were made of bricks, you would have to cut round in pretty much the same way whether the diameter was 6 inches or 9?—Unless the bricks were cut, or they were made to a radii the outside point in a 6-inch drain would be worse than in a 9-inch.

Suppose you had well-burnt earthen-pipes sufficiently strong for the communicating drains from the house to the larger sewer which would be less expensive and give a sufficient area?—If a durable, I think it would.

Have you seen such?—I have seen and used them, especially where there has been a deficiency in the current.

Have you seen them in trial?—Yes, I have; but I do not think they are so durable as a brick drain, and there is also a difficulty in taking them up to cleanse.

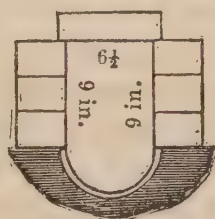
Do you think for the humbler class of houses some such as those might be adopted?—I think they might, especially if improved upon, and which might be easily done.

Have you any knowledge of those kind of pipes which have been proposed, strong burnt pipes glazed on the inside?—I have not seen any of a very new construction.

If they were glazed in the inside, would that give a freer water-way than those made of brick, which are of course rough on the inside?—They would of course be much better; and if every third or fourth was made to open, or be made in halves, or with a cover even less than that, it would be a great improvement in getting at the drain to cleanse it.

The tile itself would make a smaller waterway?—I have very often constructed drains to the smaller houses, according to this drawing, with a tile bottom, bricks on the sides, and covered with a stone or a brick, and I find that much better than the 9-inch barrel-drain, which requires so much mortar to fill up the outsides of the joints, and besides being so much cheaper.

No. 6.—Section of a Drain equal in Area to a 9-inch Barrel Drain, but much cheaper in construction, adapted to the smaller description of houses.



Cost price, 10d. per foot; the bottom, a strong garden-drain tile.

On what do you lay the tile?—On the earth itself, and the brick side, just clear of the tile.

Is not there a bad joint?—No; if it is flushed in with a little cement its makes a much stronger description of drain than the 9-inch barrel-drain.

If they were made of tiles well burnt, and glazed inside, would they not give a freer waterway than those made of bricks?—Yes.

They would in consequence require less declivity than if made of bricks?—Generally speaking, pipes are used where we cannot get so much current.

That would give you an opportunity of having them shallower?—Yes; there would not be so much digging.

That would be of advantage, in giving you a clear waterway?—Yes; where I can get a current I never hesitate about the expense of a little digging.

Have you any experience of the quantity of water necessary for working a drain of this kind?—No, I have not; but the usual run of water from a house is generally found sufficient.

You state that an 18-inch barrel-drain is sufficient where there are forty or fifty houses; are you acquainted with any mode by which earthenware pipes might be sufficiently large and sufficiently strong for small barrel-drains, to carry the drainage from two rows of houses into the common sewer?—I am not aware that such large pipes are at present manufactured.

You have never used box tiles for the purpose?—No; except those termed "drain-pipes."

Mr. Hugh Biers.

Do you conceive they might be used for making drains at much less expense than those made of brick?—I think it possible that pipes may be constructed to cost much less than the present brick drains.

Do you think it would be desirable that, for smaller houses, this kind of drain should be adopted instead of those made of brick?—Anything that would keep down the prices of the present system of drainage would be an advantage, to the humbler classes of houses especially.

That would give a great facility for draining many which are not drained at present, owing to the expense?—My endeavour has been to get a much smaller description of sewage than that now permitted for the smaller description of houses, especially where in an upper line, which cannot by possibility be carried beyond a certain distance.

You stated that the sewers were 5 feet by 2 feet 6 inches and 5 feet 6 inches by 3 feet; in what way are those drains cleansed from time to time?—There is a man-hole left about every 50 yards.

They are left to provide for the possibility of men having to go into the sewers?—Yes.

Is not this large opening requisite as long as the present mode of clearing them is continued?—As long as a man is employed to go in the sewer it cannot be of much less size than the present.

Suppose, instead of cleansing them by men going into them, they could be cleansed by water as in the Finsbury division, they would not require to be so large?—No; but I conceive they must be occasionally opened for the purpose of cleansing.

Under any plan of construction?—I think so.

You do not know that there is any district in which, by a sufficient flushing of water and a proper construction with a valve at the top, the water would be sufficient to carry off the matter?—I am not aware of it; but if so there must be a very excellent supply of water.

If that could be done, would not a less sized sewer be sufficient?—Whether or no, a less sized sewer would very often be quite sufficient.

That would lead you to make drains much less expensive?—That is what is very desirable.

Then probably the Westminster Commissioners would have no objection to decreasing their size?—I should think they would not object; and I think they have seen the evil of compelling, in every instance, these large sized sewers; they having come to the determination to give permission for 18-inch barrel-drains, or something of that description, for surface-drains, or upper drainage; but that permission is made almost inoperative, for it is with the condition that the persons constructing shall be at the expense of cleansing these drains, instead of the Commission. Those who

have the control of the several public ways will never take to the roads, so long as the sewage is under the control or superintendence of private individuals. Mr. Hugh Biers.

You have spoken with reference to the cleansing of the sewer; do you mean, that if the water continues passing down in dribblets it would not be sufficient? or that if the same quantity of water were dammed up for a certain time, and then let down in a current, that would not be sufficient?—It is difficult to say; there are so many circumstances to be considered. In the upper part of the drain you do not get the same quantity of water as in the lower part; the water as it progresses increases. It may be sufficient in one place and not in another.

The part which was flushed would do, but not the other which was not flushed?—The first consideration in a sewage is a proper supply of water.

Do you think that part which was flushed would do?—Yes; but that greatly depends upon the flushing to carry off the whole of the sullage from the different houses, and the mud from the streets as well. I think it would require a very large supply. I have been informed that such is the case; but I have not had much experience in that matter. The plan and section No. 4 would be a sewer of quite sufficient area for an upper drainage, if such was permitted to be built, with a man-hole or entry, which, if left, perhaps, every 50 or 100 yards, might be very easily taken up, and although not large enough for a man to go into it, the sewer might be cleansed.

What size have you made yours?—The sewer has an inside area of about 6 feet, the man-hole about 4 feet long. There would then be the means of getting in at both the ends, with a rake to cleanse it of any accumulation; it would require some contrivance of that sort if a sewer of that size was constructed.

How would you propose to get the soil out?—By raking both ways towards the man-holes, the soil might be taken out; or if it was stirred up, a great deal of it would go away if well flushed with water.

You state that if a smaller description of drain was allowed, many places now without a sewage would have one quite sufficient for their purpose?—I have no doubt of that.

Is that with regard to districts at present not built on, or with regard to districts on which houses are at present built?—With regard to districts at present built on, I know several places which are without proper sewage, in consequence of the great expense of the construction of a sewer, according to the present regulations.

Does that refer to whole streets?—Yes.

Of what description of houses; what class?—Of almost all classes, as the Alpha cottages: a considerable number of these are not drained by a public, but by a surreptitious drainage. Part of Portland Town is in the same way; a portion of Lord Portman's

Mr. Hugh Biers. estate, now undrained, or only drained by surreptitious drainage, but which would be drained in a proper way if a less expensive description of drainage were allowed. There is also a large number of houses of the smaller description, built at the back of the Edgware-road, called Hall-park, without a sewage, in consequence of the great expense.

What class of houses are those without a proper sewage?—Of the third and fourth rate generally; but the Alpha cottages are mostly very respectable houses. The expense of sewage is looked at principally by builders of the smaller description of houses. I should perhaps state that the reason the Alpha cottages have not the usual sewage is, that they have very large frontages, and the sewage would cost almost the value of the land, if constructed on the present scale of expense.

Do you know whether any surreptitious drains are carried into the canal?—No, I should think not.

What description of sewer would you recommend to meet the wants of those houses?—At all events not above half the size of the present smaller Westminster or Finsbury sewers, and similar in plan and section as drawing No. 4.

You consider that the expense of that would come within the means of the inhabitants of those houses?—I think they would have had no objection at the first building, but having now got a drainage, whether the same may be a good or a bad one, I think they would now object to any further expense.

What is the size of the present smaller Finsbury sewers?—4 feet by 2 feet 6, I think: there is one lettered C in Mr. Roe's Report, which is a very good one, but still with the objection of being built in circles with bricks of a square form.

Supposing the cost of these main sewers were to be spread over a number of years, and to be paid by equal instalments, by collections from the occupiers, do you consider that that would be an inducement to persons to construct those sewers?—As regards new houses, there is no doubt that then there would be a very good drainage; it is the first outlay, which is so large that builders, especially small builders, avoid the expense wherever they can.

The Commissioners would have to provide for it, and be repaid by instalments by the occupiers?—I think that would be a very excellent plan.

Would you in that case recommend that the private drains from each house to the sewer should also be constructed by the Commissioners or by the occupier?—I think it would be best if they were constructed by the Commissioners up to the house, and then leave the owners to deal with the drain inside as they pleased.

Making them pay by instalments for the expense of the main sewer, and also for the drain up to the house?—I see no difficulty at all in that matter.

Would you consider it beneficial that such an alteration should be made in the regulation for the construction of sewers in the metropolis, that the Commissioners should form the great sewers as well as the drains ; the expense being paid by instalments?—*Mr. Hugh Biers.* I think that would be a very great improvement upon the present system, inasmuch as you would then get a drainage to every street, and from every house.

Do you think that arrangement would not be objected to?—I think not ; it would certainly not be objected to by the builders.

Would that have the effect of increasing the sewer-rate?—Every person would still have to pay the present sewer-rate, which is for repairs. The payment of the instalment would be thrown upon those who receive the benefit of construction, and which I am sure would not be objected to by the builders.

Would it diminish the rent taken by the builder for the houses?—In the smaller description of houses the builder or proprietor now pays the sewer-rate ; it is a landlord's rate, and it is only where there is a special agreement it is now paid by the occupier of the house.

According to the present arrangement the builder must get repaid for the amount of the construction of the sewer?—If a person was to purchase a house he would say what is the outlay ; there is a ground-rent of 3*l.* or 4*l.*, and there is the sewer, I shall have to pay for. Under the proposed arrangement he would have to pay a small annual addition. He conducts his bargain according to the sum of money he has actually to disburse ; but under the present regulations, the poor occupier has to pay from 10 to 12½ per cent. upon this first cost or outlay.

Do you think such a system would be applicable to the smallest class of houses?—I think it would be as applicable to them, or more so than to the largest description of houses ; the builder of the large houses does not care so much about it, for it is comparatively of little importance to him whether it is 20*l.* more or less ; but the strong objection is the present expense upon these smaller description of dwellings.

Are these dwellings generally supplied with water?—Generally they are supplied ; at the same time paying very dearly for it.

Are they supplied with water-closets?—Not the smaller houses ; these have privies : there is a cesspool generally built for the privy, and which also serves for the reception of the waste water from the whole of the house ; from that cesspool there is a drain communicating with the sewer, that is to say, where there are sewers and drains.

Where there is no drain for that what becomes of the surface water?—The soil, and also the surface water, is then collected in a cesspool, which is emptied occasionally ; they, of course, if not attended to, will overflow ; and also the damp, in consequence of

Mr. Hugh Biers. such want of an outlet, must be very deleterious to the health of those occupying the houses, and where there are a large number of houses wanting such drainage, I should say of the district.

Would it not be a proper provision that there should be a communication to the sewer from every house to take away that which must be so deleterious to the health of the inhabitants?—There is no reason why that should not be effected if the expense was so adjusted as not to press too heavily on the poor; there would be no objection to enforce the regulation under a cheap mode of drainage.

Do you think, in case that were done, drainage might be effected in some of the more densely-populated parts of the metropolis, where no drainage at present exists?—I think it might be effected to a considerable extent; but generally speaking it is difficult to get people out of their habits, and, even if the drainage was brought up to their very doors, if it was to put them to any considerable additional expense, I think they would not be very anxious about it. I am speaking now of districts already built upon.

You think it desirable to make it peremptory to build such drains?—If it could be done without putting the parties to a great expense, I should certainly say that a drainage ought to be compulsory.

Have you seen the General Report on the Sanatory Condition of the Labouring Population?—I have read the first volume of it.

Will you refer to pages 453 and 454, and read the suggestion which is there made?—

“SUGGESTED FORM of Notification to Owners or Occupiers for the distribution of the expense of permanent alterations, and the avoidance of overcharges on persons enjoying only portions of the benefit.

“The Commissioners of Sewers appointed to superintend the execution of the Act of Victoria, passed for the protection of the public health, which requires that every inhabited tenement shall be provided with proper means of drainage and cleansing, and the removal of refuse, have caused a survey to be made of the houses and tenements in

[court or street, as the case may be]. On this survey it appears that your house, with others in the same place, are without the requisites required by law; that they are without proper sewers, without drainage from the house, and without water or proper means for the constant removal of night-soil, or conveniences for cleansing,

“By the section of the Act the several requisites hereunder described are directed to be provided and completed within months after this date.

“The Commissioners have directed tenders for contract upon specifications to be taken for the execution of the required works, under a civil engineer, in the most beneficial manner, and at the lowest cost.

“They are also prepared to take loans on the security of the rates, for defraying the expenses of the execution of the works contracted for.

“It will be at your option either to repay at once the cost of the requisite works by which the property will be benefited, or to repay it by

annual instalments in thirty years, paying five per cent. interest on the principal sum expended, or on that part of it that may, from time to time remain unpaid. Mr. Hugh Biers.

“To save the trouble and expense of a double collection, annual instalments and the interest on the principal sums expended will be collected from the tenant with _____ rates. Where the landlord is under any agreement or obligation to cleanse the cesspools, the tenant will be entitled to deduct from the rent the charge for the drainage and apparatus for cleansing. Where the tenant pays rent weekly, or at shorter periods than quarterly, and does not pay _____ rates, the charge for the works in question is required by the statute to be paid by the owner of the tenement, who will levy the amount with the rent, or make his own terms with the tenant for the improvement in question.

“The cost of the required improvements or principal sum, which will be charged at the contract prices, together with the annual instalments and interest thereon, and the weekly charge or improved rent that may be due or charged on the weekly tenant, will be as follows:—

First Outlay per Tenement.	Annual Instalment for Repayment in 30 Years.	Annual Interest, commuted at 5 per Cent, on Outlay charged as Rent on Tenant, and Annual Rent of Water.	Weekly Charge to the Tenant, or Increased Rent.
£ s. d.	s. d.	s. d.	s. d.
Water-closet } 10 8 6	6 11	6 8	0 3
Water-tank }			
Drain			
Main sewer. 5 12 0	3 9	3 6	0 1½
Water . . . . .	..	5 0	0 1
Total	10 8	15 2	0 5½

“If the landlord undertake to cleanse the cesspools, then the additional weekly charge on the occupier for the supplies of water and drainage will be 2½d. weekly, involving, as the occupier should be informed, the conveniences, cleanliness, and security to health, and saving of medical expenses.

“Persons having only interests in property for years or for determinate periods may, by means of the above table, distribute amongst the persons successively interested in the property the portions of the charge to which they are liable.

“The surveyor and officers of sewers are charged with the duty of from time to time inspecting and seeing to the sufficiency of the means of drainage and cleansing. By the terms of the contract the contractor is bound to make good the drains for years; but the tenant will be liable to make good any wanton damage.

“The Act gives to the owner of the beneficial interest in the premises the option of executing the prescribed works himself, or giving notice on or before the _____ of such his intention, and entering into his surety to execute them within the time prescribed, and according to the contract specifications, to the satisfaction of the officer charged with the superintendence of the work.”

Do you think that such a plan as that would answer the purpose, and be beneficial to those residing in the poorer classes of tenement?—I should think it would be exceedingly beneficial.

According to that mode the charge for the maximum expense of drainage would be brought down to the charge of 6s. per an-

Mr. Hugh Biers. num, or 3*d.* per week ; would that, if levied as a rate, be objectionable even to the poorer classes of tenements?—I think not at all ; and if it could be brought down to that, I think it ought to be made compulsory ; in point of fact, where there is a sewage, the tenant is now paying treble that sum as a rent-charge laid on by the landlord to reimburse the large outlay in the construction of the sewer.

Would you make it also compulsory with regard to buildings already erected?—If it was a rate of only 6*s.* per annum, I think it should be made compulsory on both old and new ; it is true that there will be a little additional expense in the construction of drains to houses already built, but the advantages to the inhabitants generally would be more than counterbalanced by the good done to them.

Suppose the expense of laying on water, which is at present the tenant's or occupier's charge, were, for all the structural arrangements, such as water-pipes and so on, in the same manner diffused over a period of years, and reduced to the charge of about 2*d.* a-week, do you think that would, by the poorer tenants, be generally objected to?—No ; that is only 8*s.* a-year : the water-companies in the district in which I reside to the poorer classes seldom charge less than 18*s.*, and often double that, and that too after all the structural arrangements, such as pipes, cisterns, &c., have been provided by the builders.

Is the water generally laid on to those houses?—There are but few houses that have not got water supplied to them by the water-companies.

What was the scale of the 45 houses you have referred to?—Second and third-rate houses.

What were the number of inhabitants in those houses?—I should say about 10 in each house ; that is the average in Marylebone and Paddington.

Each of those houses would be equivalent to two or three of the smaller class of houses, would it not?—I think not. Generally speaking, in the smaller houses there are two families of four or five in each family. The average number of persons living in a house is 10, except in the very smallest.

If an 18-inch barrel-drain was equal to the drainage of such a number of houses, would not one of smaller capacity have done for half the number?—I dare say it would.

Were the 40 houses inhabited by one family only in each?—Generally ; but the larger the quantity of water passing through the drain so much the better, and the larger the number of persons occupying a house, generally speaking, the greater is the quantity of water passing through the main drain.

If the smaller drain would be sufficient, that would be supposing it were well supplied with water?—Yes.

The supply of water for the drains is jointly necessary with the

construction of drains in a cheap form?——Yes, in any form; it is quite useless to promote a system of sewage without at the same time promoting a supply of water, and the more abundant the better. Mr. Hugh Biers.

Supposing such a system of drainage adopted in any district, would you recommend a separate drain from each house to the sewer, or have them so constructed as that there should be a separate drain for every five or six houses?——There may be some difficulties in communications by a common drain: sometimes a person will throw things down his drain which are improper, that might stop his neighbour's drain; where there are several houses to one drain there might be sometimes some difficulty in getting them cleansed. In the Kennington district I understand they do not permit less than three houses to be drained through one main drain. In Marylebone and Paddington, under the Westminster sewers, two houses are not permitted to drain through one drain. If it is thought desirable to have but one entry into the sewer for two or three houses, I should advise that the main drain receiving the contents from the two or three branch drains be of a larger size than the branch drains.

Would you prefer that the authority respecting those drains should be under the building surveyor or under the Commissioners of Sewers?——I think anything relating to sewers should be under the Commissioners of Sewers.

So that the whole drainage should be under one supervision?——I think so.

Have you turned your attention to the mode of trapping drains to keep down the smell?——Yes, I have.

Do you think any improvement might be made in that respect?——In all the sewers I have built on the Bishop of London's estate the whole of the gullies in the roads I have trapped for the purpose of keeping down the stench.

To prevent the smell coming out?——Yes.

That keeps the smell in?——Sometimes it does; but the trap permitted by the Commissioners is but a very imperfect piece of mechanism, for the smell is often as offensive as if not trapped at all, and it is at the same time rather expensive. The Commissioners furnish the trap if the sewer is in progress of building, charging 20s. for it, but if a trap is put in after the sewer is built, then the charge is 3*l.*, and, after all, is not effective in keeping down the smell.

Supposing a man goes down to clean the sewers, does not he find them worse in consequence of your having kept all the smell in?——I dare say they are, occasionally.

Would it not be a great advantage if you could do without the man going in, and destroy the stench by flushing?——It certainly would; but this in my opinion would take a great supply of water.

Mr. Hugh Biers. Have you made a comparison of the cost of cleansing by flushing and by hand?—No, I have not.

Have you seen such an estimate?—I have gone through the Sanatory Report, and see it there stated, that the sewers could be cleansed with water, and that the expense in so cleansing must of course be much less.

Supposing that which is stated were supported by evidence, have you any doubt that would be the better mode?—There is no doubt it would be a very great improvement.

Have you known any instance of an explosion having taken place where the sewers are trapped, and the foul air confined in them?—I think Mr. Dowley, the surveyor of the Westminster sewer, was once injured by the foul air catching light, and he was severely burnt.

Unless means were taken of getting rid of that foul air it would not be safe to trap all the gully-holes?—I do not think there is so much foul air generated as many persons suppose. A great portion of it is dispersed by the water running through the sewer, and the better the supply of water the less you will have of foul air.

If you trap the gully-holes, does not the smell go up the small drains?—It will sometimes, unless they are trapped; but they are generally trapped; sometimes we are called upon to cure the smell from the drains, as they call it, and we generally find the trap has been left up, and that has caused the smell.

Do rats come up the small drains?—They do sometimes, but they can be kept back by proper traps. I do not much object to rats in the drains, provided they do not come into the house.

They make good scavengers?—I think they do; for in taking up a drain we sometimes find that the soil has been paddled away, and a great deal of it no doubt mixes with the water and is washed away.

Those men who go into the man-holes stir it up in the sewers, and the rats in the drains?—Just so; and I think the rats in a drain are much more serviceable than many persons imagine.

A good system of flushing would do better than the men or the rats?—I think it would; but I am still of opinion that the rats are not altogether useless in the operation of cleansing a small drain.

Are bell-traps, where used for drains, often left dry?—Not very often; a pint of water, and about half a minute's work, will effectually trap any drain having a bell-trap. I have seen traps in private houses not only dry, but filled with dirt, so that water could not get through them; that is from persons not knowing how to manage them; but it is very soon put to rights.

Do you find the men that clean the sewers are subject to any particular disease?—No; I never found that, Mr. Hugh Biers.

Do they meet with any particular annoyance?—I think not. I have travelled through some miles of sewers: the only annoyance I have met with has been when there has been too large a congregation of rats.

Do you ever hear the men complain of it?—No; there are always plenty of hands to be had for that description of work.

Is it consistent with your experience that ventilation might be secured in the houses of the poorer classes in a simple manner without much cost?—I think so. It is very important for the poor.

Can you state any form which appears to you the most simple and cheapest, to secure ventilation in the houses of the poor?—As regards the foundation, the most simple and the most effectual is to put air-gratings underneath the floors, so that the foundations have an imperceptible current of air passing through them.

The question refers to means for the escape of impure air in the part inhabited?—That will materially assist the ventilation in the other parts of the house; but there is another way of doing it, by putting something like a hopper in the ceiling of the staircases.

A self-acting ventilator?—Yes; and there is another method, very cheap and very simple, merely boring a few holes in the trap-door usually placed in the ceiling of the staircase. This will permit an escape, continuous but imperceptible, of a large quantity of contaminated air from the upper part of the house, and consequently from the lower part into the roof.

You think it would be possible to enforce any means of ventilation, when coal is at its present price in London?—I think you cannot enforce, but still it would be desirable to recommend.

You think it desirable that there should be means for the discharge of vitiated air?—I think so. A single apartment is often used for cooking, washing, working, and sleeping, and the windows all closed; you cannot make people open their windows; but it is very desirable to impress upon them the benefits of a proper ventilation.

They have an opportunity of letting in the air?—Yes; generally in the lower description of dwellings there is a want of ventilation, especially in the old houses, where eight or ten families reside in the same house.

The self-acting ventilators would not admit of being obstructed?—I think the plan of ventilating by the trap-door in the ceiling of the landing, and through the roof of the smaller description of houses, might be adopted with advantage.

Have you ever introduced any into the smaller description of houses?—I have not had much occasion to ventilate in the way described: and I am sorry to say that, from the way in which the

Mr. Hugh Biers. window-taxes are levied, so far from promoting a better ventilation, I have been obliged, in several new buildings I have lately constructed, and they are buildings of a superior class, to do away with some of the ventilating lights, such as under the steps; and in the larders, outhouses, and so on, where I should have had two, three, or four, there is now but one.

You consider that a subject of great importance?—I certainly do; so much so, that in a Building Act, a short time since proposed for the consideration of the Commissioners of Woods and Forests, we suggested that the ventilators or lancet-windows should be permitted in houses, particularly of the lower class, without making them chargeable to the window-tax, unless the place in which they were was used as a dwelling-room, and then that the tax should be charged; but if it was purely for ventilation, the community ought to have the advantage of it.

Even where a room is allowed for dwelling, you do not see any objection to an aperture for ventilation, which should not be charged with a tax?—No; but the assessors can charge the tax if the opening is in an external wall.

Suppose it were a hole in the wall to let off the impure air?—If glazed, the tax-gatherer would most decidedly charge for a window. I have, however, constructed three air-flues in a party wall of one of my workshops, each having a shutter to open and shut, and the same flues answer for all the stories.

What is the size of those flues?—9 inches by 14.

How many workpeople may there be in those shops?—Not many; but it was not so much for the number of workmen employed as the advantage derived by the ventilation, particularly in the cellar story, which is in rather a confined situation.

Do you find any of the workmen desirous to close it?—No; they open it occasionally when they want the air; they have a sliding shutter to open or shut as they please.

Have you a fire in that workshop, or cellar story?—In neither of the stories ventilated in this way is there a fire-place.

Do you not apprehend that in common cases an opening above would interfere with the fires, or rather admit air instead of taking it off?—Where there is a chimney and a window, I think, generally speaking, there is a sufficient ventilation. If I had had a fire-place in either of those rooms, perhaps I should not have wanted those flues; but it was in consequence of my not having a fire-place that I made those apertures.

Do you not find that there are in many apartments in the smaller houses cottage grates, which have fires, but which are very badly ventilated above the grates?—It may be so; but I think, with a chimney and a window, a sufficient ventilation can be obtained.

You stated that the poor sometimes improperly throw rubbish down their drains; does not that show that they should have some

spot where they can throw ashes and things of that kind?—An *Mr. Hugh Biers.* ash-pit or dust-hole is generally provided to almost all dwellings.

Is it not necessary that some place of that kind should be secured to them?—Generally they have one, but what they throw down those places is something they wish to hide, as broken china; sometimes accidentally a scrubbing-brush, house-cloth, and other things; these accumulate, and in time stop up the drain.

Is it not necessary, for the sake of cleanliness, that they should have a receptacle provided for ashes and such matters?—Yes; but I think I would leave that to the fancy of the persons themselves. I do not like ash-holes near a house, where I can get rid of the ashes without them.

Have you seen the plans for the ventilation of drains or sewers now adopted?—I have noticed that now introduced into the city of London, and also that in Finsbury, namely, by a grating in the centre of the road, at little distances, over the centre of the sewer.

Is not a very large quantity of foul air discharged from such gratings?—No doubt there is.

Would it not be desirable that, instead of allowing that vitiated air to be poured out into the street, which might be directed by a current into a particular house, it should be carried into a shaft, or other means adopted for passing it off?—That has been suggested, and also to burn the contaminated air; and if the sewers could be freed of that foul air without a large expense it would certainly be desirable; but I think the expense would be against it.

Would the expense be anything beyond the building of the shaft —The purchase, or ground-rent of the plot of ground for the site to build such shaft on, the superintending it, the burning the air, the repairs, &c.

Suppose the burning of the air were to be done away, and that it were simply a communicating channel, so that air might enter at the mouth of the river and pass up through the sewer, that the whole might be considered as a chimney?—Persons would not like to come and live very near those chimneys; they would suppose the air contaminated, and the vicinity of such chimneys would be avoided both by inhabitants and builders; but if a contrivance of the sort was to be carried out, the best plan would be to drive the foul air towards the river, instead of from the river into the town.

Do you not think it is still more objectionable that the air should be permitted to come out in the middle of the street?—I think it is in such small quantities, so gradual and imperceptible, that it is not of any great importance. I have endeavoured to detect smells from these gratings, but have been seldom able to do so.

Are you aware of a cheap description of water-closets fit for the

Mr. Hu h Biers. poor?—I have used a cheap description—the common hopper and shoe, in cast-iron.

Have you made any comparison in cost of the cheapest construction of water-closet with the expense of a privy, and the constant necessary expense of cleaning it by hand from time to time, and carting the soil away?—The expense would not only be in the construction but also the expense of laying on the water; and it would increase the size of the cistern. I would observe, that it is very seldom necessary to empty the cesspool and drains by hand where there are sewers, and a moderate supply of water.

With a good supply of water you would think that a cheap water-closet was very preferable to a privy?—Yes, it would be generally, no doubt; but it should be, for the smaller class of houses, simple in construction, durable as to the materials, not liable to get out of order, and not expensive if necessary to repair.

Supposing a system of sewage with an ample supply of water were established, should you consider it any hardship on the public if the construction of cesspools were entirely prohibited?—I think not; but the price of water must be always borne in mind. The public are now left to the mercy of companies, who, I have no doubt, would say, you supply your water-closets now, which you did not do before, and we shall charge you so much extra for that.

Suppose water supplied at the rate stated a little while ago to the poor?—At twopence a-week—I should say if it could be supplied at that price it would be a great advantage to do away with cesspools. But how can you supply water at twopence per week, when the companies now in possession charge to the poor at least three times that sum? and if they happen to take in a little washing, charge another pound or two for that.

Do you not think that the prevalence of cesspools contaminates the soil, and affects the supply of water from pumps and wells?—It may sometimes escape; but if so, it would soon be found out; the water would not be drinkable. I think if you could do away entirely with cesspools it would be a great advantage. I used invariably to build cesspools, but I now do entirely without them; and I sometimes fill up an old cesspool, and often find it a remedy for bad smells, which have puzzled and annoyed the inmates of the house for years.

Are there any other suggestions you have to offer to the Commissioners?—I would most respectfully submit that there are four primary objects to be kept in view in legislating for the comforts and accommodation, especially of the humbler classes of the community, namely, cheapness in the construction of their dwellings and the several appendages necessary to make a working man's home comfortable; a plentiful supply of good water at a cheap rate; a sufficient sewage and drainage at a reasonable cost, and the promotion of ventilation. These, if properly carried out

would be of most essential service to the poor. It may be taken as an axiom, that if you make a working man's home comfortable, he will give up the public-house and its ruinous consequences; and that where a working man's home is little better than a pigsty, that man will almost be an inhabitant of the public-house or beer-shop. I say this confidently, from my experience of the habits of large numbers of the working-classes.

MR. JEREMIAH LITTLE, builder.

Mr. Jeremiah
Little.

WHERE do you live?—In Omega-street, near the Alpha-road.

You are a builder, and have built houses?—Yes.

Why were the streets so named?—Alpha-road is the beginning of Colonel Eyre's estate, and Omega-street is the end of Lord Portman's estate.

What description of houses have you principally built?—I have generally been building fourth-rate houses; I have built also third-rate houses; but I have built most of the fourth-rate houses; last year I built and superintended 50 and upwards.

What description of persons usually occupy the fourth-rate houses which you have built?—Mechanics, usually, or persons whose earnings average 24*s.* a-week.

At what rates do you let the fourth-rate houses which you build?—At 20*l.* a-year for the four-roomed houses; and at 30*l.* the six-roomed houses; of this the ground-rent is about 4*l.* per annum.

In what periods do you collect the rents?—About one-third monthly; and the rest we collect quarterly.

What may be your losses on the collections?—They will average, perhaps, about one-fifth; we lose rather the most on the quarterly tenements.

What are the chief causes of your losses from this class of tenants?—Loss of work first; then sickness and death; then frauds.

Are the frauds considerable?—Not so much as the inabilities to pay. I find the working-classes, if they have means, as willing to pay and as honourable as any other class. Within the last 18 months there have been a great many people out of work; at other times there is as much loss to the landlord from sickness as from any other cause. Three out of five of the losses of rent that I now have are losses from the sickness of the tenants, who are working men.

When children are sick, there is of course no immediate interruption to the payment of rent?—Very seldom.

What sort of sicknesses are they from which the interruption to work and to the payment of rent occurs?—Fevers, nervous disorders, and sickness that debilitates them.

Then anything which promotes the health of the tenants will

Mr. Jeremiah
Little.

tend to prevent losses of rent to the owners of the lower class of houses?—Yes; I have decidedly found that rent is the best got from healthy houses.

Have the fourth-class houses which you have built sewers, drains, or water-closets, and water laid on?—They have sewers, and drains, and water laid on, and privies running into cesspools; these cesspools drain into the drain which runs into the sewer.

What does the common privy, and the cesspool, and the drain from a house of this description cost?—About 6*l.* or 7*l.*; of this, the privy will cost about one-half, and the cesspool and house-drain the remainder.

What will the sewer cost besides these?—According to the regulations of the Commissioners of Sewers it costs about 10*s.* per foot, which, on the fourth class of houses, makes 7*l.* 10*s.* for each fourth-class house of 15 feet frontage; besides that, there is the entrance-fee, which is one guinea for a nine-inch barrel-drain.

You are required to make this sewer of the second-class size; that is, with spreading footings and upright sides?—Yes; and I have to do this in a street of only 16 houses, Henry-street, Blandford-square; this is a street with only eight houses on each side. A sewer of one-half the size would have been quite sufficient for the houses I have built. It is the general complaint of the builders of such houses, that we are compelled to build sewers of double the size that is necessary.

If you had been allowed to put the ring of the drain into the sewer at the same time that the sewer was made, for how much could you have done it?—For 5*s.*

Would it have been quite as good work for the 5*s.* as for the guinea?—Yes; I am sure it would. Another evil of which we complain is the great expense attending the sewers and paving of corner houses. Suppose a corner house with 15 feet frontage, 22 feet deep, yard 16 feet, half the street (supposing it to be 30 feet wide) 15 feet, and half the street again in front of the said house 15 feet, the whole length of sewer for such house will be 83 feet; at 10*s.* per foot, is 4*l.* 10*s.* In most cases the corner house has to bear the whole of this great expense, which I think ought to be equally charged among the streets of houses.

What is the cost per foot of the lowest class of drains used in the lowest class of tenements?—For the nine-inch barrel-drain of brick it is about 1*s.* 6*d.* per foot.

How many feet of drain have you to each house?—From 40 to 50 feet on an average.

How much will the 8*l.* 10*s.* per house, for the sewer and entrance-fee, add to the rent of each house?—Putting it at the usual rate of purchase for such property, or at the return which is the usual inducement to build, that is 10 or 12 years, it would be about 18*s.* 9*d.* a-year; then we have to pay a sewer's rate, which amounts to 2*s.* 6*d.* per annum for each house.

Are there not complaints of smells from the drains or sewers, as they are at present constructed?——Very often; I have had them complain that these smells cause a sickness; but I believe this has arisen most from the smells in the drains.

Mr. Jeremiah Little.

Are you allowed to make one entrance to the sewer serve for several houses; one for each four, for example?——Oh, no; we must make a drain from every house, and an entrance into the sewer.

Then you pay for these 16 entrances 16 guineas, which you say you could have done yourself for four guineas?——Yes.

Are these openings in the sewers trapped?——No; there are 16 untrapped openings from the sewers to the houses.

It is, then, to be collected, as you complain, that the unnecessary size and expense of the sewer occasions an addition to the rent of 5s. a-year to the labouring man?——Yes, certainly.

You complain that the drains are defective; would not it be a better to make drains of stone and earthenware glazed pipe, which is half the price and less permeable to effluvia, than brick?——Yes, if the earthen pipes were of sufficient size, that would be better certainly.

If such drains were built on a general system, might they not be made much cheaper than they are made even now by the private builder?——Yes, greatly less; and my opinion is, that they ought to be made either by the persons who build the sewers, or under their instructions.

Do you find the necessity of the first outlay of money an obstruction to such work for the fourth-class of houses?——Yes, it is a great pull-back to have so much money to pay for the sewers and drains, and it is the reason why they try all they can to evade them.

Would it, then, facilitate such work, if drains as well as sewers were made on contract, in the best manner and the lowest cost, by the Commissioners of Sewers, or some competent and really responsible authority, and the cost were levied by equal instalments, say, of 30 years, principal and interest, as an additional rate from the occupier?——In my opinion it would be a vast improvement; it would greatly facilitate the erection of a better sort of houses.

What is the expense of laying on water to such houses as the fourth-class of houses of which you have been speaking?——Very little less than 4l. per house, including lead pipe, ball and cock, and water-tank or water-butt.

For this you must charge 8s. or 9s. of additional rent; might not a cheaper apparatus be provided, or one tank be made to serve several houses?——Yes, it might be so, but the water-companies will not allow one tank to supply more than one house. The companies can enforce a penalty, if one tenant allows another to take water from the same tank or butt. One tank might have been made to serve for each side, or eight houses, of the street

Mr. Jeremiah
Little.

which I have built. They also compel us to have the same sized ball and cock as for a large house; we are obliged to have inch pipe, when three-quarter inch pipe would do.

What are their reasons for this?—I believe they save engine-power by it; as by the larger pipe they deliver the supply in a shorter time.

What is levied per tenement as a water-rent on the four-roomed houses?—26s. a-year; on a six-roomed house they charge 38s.

What is the cost of the water-tank and ball-cock?—Perhaps 30s. per house. Then there is about 50 feet of pipe besides.

Why do you use lead pipe exclusively, iron pipe being half the price, and having a less injurious oxide; or is it the plumber's opinion on which you act, in using the most expensive material, it being stated that hard tile pipe, which might be used for some lengths, is to be had for a halfpenny per foot?—Iron is not made so as to bend, as lead is; and perhaps the water in iron pipes might be more easily frozen than lead.

But might not iron pipe be got with bends for use?—Perhaps it might, but it is not at present.

This 30s. for the water-tank would then occasion an additional rent of 3s. 4d. per annum. It is stated that under general arrangements the water may be supplied to each labouring man's house for 7s. per annum, and may be always kept on at high pressure, at an extra charge for such high pressure of about 1s. 4d. per tenement; and that for this sum it may be kept on night and day, ready at a moment to be brought to bear, by means of a hose, to extinguish a fire in any room, and to be used also for cleaning the windows and the pavement, and watering the streets. By such an arrangement, saving the expense of water-tank, and the deterioration of the water, exposed to soot and dust, supposing it to be practicable, as engineers and men of practical experience have stated, would not the cleanliness of the houses and streets, the comfort, and security, and health, and general condition of this class of inhabitants be much improved?—Undoubtedly they would, and it would be an important boon.

Do you insure the houses?—Yes, I am under covenant from the ground-landlord to insure to two-thirds of their value. The value of the four-roomed houses is about 150l., and of the six-roomed houses about 250l.

These are in general inhabited by more than one family, are they not?—Yes, the four-roomed houses are on the average inhabited by two families, and the six-roomed by three, and sometimes more.

What proportion of the inhabitants insure their goods?—About one-fourth, perhaps.

What may they insure for?—Generally about 100l.

Would not such an arrangement as to the water, having it

always ready night and day to be brought into a room at once to extinguish any fire, without waiting for any engines, greatly diminish the risk and charge of insurance on such houses?—Certainly, it ought to do very much.

Are there any complaints as to the quality of the water?—Sometimes very great complaints; that it is thick, bad-tasted, and dirty.

What is the district surveyor's fee on each house?—The proper fee to a fourth-rate house is two guineas.

This fee then will add 4*s.* 6*d.* to the rent per annum permanently?—At least that.

How much of the surveyor's time is occupied in the duty of inspecting each house?—Three or four minutes, perhaps. Usually he calls twice, though it is sometimes more.

Might not the sewer's surveyor and his assistant in new districts perform the duty of seeing that the party-wall, and the provisions of the Building Act, were complied with?—Yes, they might do that with very little more trouble, and one notice might serve.

Would a survey, which might be consulted for the levels, be of use to builders?—Yes, it would be a great accommodation if the levels for the houses, for the drains, and for the pavement, could be directed by one body. They now occasion very great interruption to the work being arranged and done properly. In every building there is a great interruption from their not being done properly.

The unnecessary charges on the fourth-rate tenement would then appear to be nearly as follows:—

	£.	s.	d.
Sewers 7 <i>l.</i> 10 <i>s.</i> ; instead of 4 <i>l.</i> ; entailing on the annual rent an excess of	0	7	9
Cost of inserting the neck of a private drain into the sewer, 1 <i>l.</i> 1 <i>s.</i> instead of 5 <i>s.</i> , an excess of	0	1	9
Private drains 3 <i>l.</i> instead of 1 <i>l.</i> 10 <i>s.</i> , an excess of	0	3	4
Water apparatus 4 <i>l.</i> instead of 2 <i>l.</i> , an excess of	0	4	5
Water supply, annual, 1 <i>l.</i> 6 <i>s.</i> instead of 8 <i>s.</i> 6 <i>d.</i> , an excess of	0	17	6
Surveyor's fee 2 <i>l.</i> 2 <i>s.</i> instead of 10 <i>s.</i> 6 <i>d.</i> , an excess of	0	3	5
Fire-insurance risk 10 <i>s.</i> instead of 2 <i>s.</i> 6 <i>d.</i> , an excess of	0	7	6
£.	2	5	8

Entailing on the builder of your class of labouring men's tenements an immediate outlay of 17*l.* or 18*l.* instead of 8*l.* or 9*l.*, and subjecting the labouring men's families, who inhabit each house to a perpetual excess of nearly 2*l.* 6*s.*, for household purposes, for an administration which produces drains and openings into the houses, and sewers which emit pestilential smells; water which is sometimes complained of as bad, and scanty in supply for fires: is this so?—Yes; I consider this is our case, which it will be a great saving and blessing if we can have remedied.

Mr. Jeremiah
Little.

That is omitting the extra insurance for sickness. Now, as you say that two out of three of your losses of rent occur from sickness, how much may the extra charge of rent be reduced by improvement in the tenement which shall diminish, as medical men declare to be practicable, the sickness by one-half?—I think that the extra rent to cover risks cannot be less than 30s. a-year for a four-roomed tenement; and two-thirds of the losses being mostly from sickness of one sort or other, if the sickness were reduced one-half, it would reduce the annual charge at least 10s.

You have read the suggested form of notice, prepared to exemplify the mode of spreading the charge of new works for the improvement of the health of the labouring population, where the builder or owner preferred not doing them himself; suppose, for new districts, the works were carried out in the manner therein described, and payment were levied by instalments of principal and interest, do you conceive that such a mode of execution would be deemed unobjectionable by the tenants as well as the landlord?—I really think not; I, as a builder, very much approve of it.

It is stated as an objection to laying on water on the poorer tenements, that the tenants would cut the pipes, and steal the lead; do you sustain frequent depredations or losses?—It has not occurred in my neighbourhood; and I do not think that an important risk.

If a simple form of water-closets were introduced, do you think it would be spoiled?—If something could be constructed as a water-closet on a simple plan, it would be a great benefit to the labouring classes; and I think there would be no danger worth noticing of its being put out of order or damaged wantonly.

Mr. CHARLES BRATT, examined.

Mr. Charles
Bratt.

You reside in Church-street, Spitalfields?—Yes.

You are the owner of a considerable number of tenements in that district?—In Spitalfields and Bethnal-green.

Do those tenements derive much advantage from the sewers there?—I am very sorry to say that very few of them do.

Notwithstanding that, you have to pay sewer-rates upon them?—Yes, every one of them.

Will you describe some of the difficulties experienced in getting any sewage in that populous district? I have repeatedly applied to the Commissioners of sewers on the subject, and never yet with any success in some of the districts. Some of the inconvenience I have experienced is that where I have been willing to lay a drain of considerable length, I have met with refusal, and been told it must be a second-sized sewer.

What has been the size of a second-sized sewer?—I do not recollect.

Is it a large and expensive sewer according to the regulations?
——Yes.

What size were you willing to have laid?——In the case I especially allude to, I would have laid an 18-inch barrel-drain.

For how many houses?——For one.

Were you prevented from so doing by some regulation of the Commission?——Yes, I was compelled to pay a sum of upwards of 60*l.* to the Commissioners of Sewers for laying down a sewer.

Does the fact of a great number of tenements in that district not being drained arise from the nature of the regulations which had been laid down by the Commissioners?——It arises from the want of sewers within reach. In many places, the water lies above ground for the length of half a mile.

There is no underground sewage, and yet those houses have to pay the sewer rate?——Yes.

How long have the owners of that property paid rates?——I am now 60 years of age, and I recollect that district ever since I was 14. From that period they have paid sewer rate.

And no sewage has been carried up to the houses?——None whatever.

Have you any evidence as to the previous payment of sewer rate on that same property before your own recollection?——It is understood to have been paid for the last two centuries.

Are there not expensive regulations, with respect to joining the drain from each house into the sewer, so that the Commissioners require that you shall pay so much for the junction, and so much for two or three feet carried up?——Not very expensive, I think, in our district.

How much?——I think I paid something about 9*s.* for the last I did.

That is for the first yard?——For the first yard. I am so desirous of getting sewers wherever I can, that I do not mind trifling expenses.

Do you think there might be an improvement in the regulations, as to the expense and sizes of sewers that would make the system much more effectual for the purpose of draining the humbler classes of houses?——I think there might.

Would it be of advantage, that plans as to private house drainage should be prepared after good consideration for the use of builders. Have you ever found any difficulty from the want of such a plan?——On application for a drain, in many instances it is necessary that a plan should be prepared, and the individual applying for the drain cannot prepare a plan without applying to a surveyor, and paying a guinea for it, and I consider that a needless expense.

Have you experienced that yourself?——I have. I wished to lay a drain to a house, and I was obliged to get a plan drawn and annexed to the petition, before the question could be entertained.

Mr. Charles
Bratt.

Was that plan adopted?—It is the case I have alluded to, wherein, after having been at that expense, the report of the surveyor was, that nothing less than a second-sized sewer could be allowed to be laid across the street.

What did that cost?—Upwards of 50*l*.

Does the health of the populous district, in which you reside suffer much from the want of improved drainage?—Greatly.

With respect to paving the surface, and the cleansing and the scavenging from time to time in the humbler parts of the district, is that also in the same measure neglected?—Yes.

Does the health of the district suffer from those causes also?—It must suffer greatly.

Does it require some inspector or public officer to see that the duty is performed in that respect?—I think in some degree it arises from the persons, under whose control the cleansing the streets is, for not making a contract for the sufficiently cleansing them. For instance, in the parish where I reside, I found a little while ago, to my surprise, that certain small streets and courts are only contracted to be cleansed once a-month.

Have you a good supply of water?—The supply of water which the Company contract to let us have is rather scanty. It is three times a-week, and the time they propose to have it on is two hours. Sometimes the turncocks let it be on a little longer.

Do the tenants complain of the quality of the water as well as the quantity?—I have not heard many complaints of the quality of the water. I have occasionally, but not often.

It is understood that in your district, when an application is made for a sewer to be brought up any small street which had no drain before, the Commissioners require the proprietors of the houses to pay a certain portion of the expense?—Yes.

Do you find a difficulty sometimes in getting all the proprietors to agree to that?—Very great difficulty, because we find proprietors very frequently, who wish to be benefited at any person's expense but their own.

Do you think it would give facility for making the necessary charge, if it were spread over a period of several years, in which the respective parties should pay according to their interest, the owner of the fee so much, the owner of the lease so much according to his lease, and so on?—Certainly the spreading of those expenses would be a benefit, particularly in the district that I allude to. It is an old-built district, a district which has been paying sewer rate a good many years without benefit.

Do you think that some such alteration would give facilities for making sewers in those districts?—I can hardly form an idea. The Commissioners of Sewers in our districts seem to be very negligent in attending to any applications. Some little time ago there was an application to the Commissioners of Sewers very extensively signed by individuals, who took some interest in the

neighbourhood of Spitalfields, requesting that a sewer might be laid down in a certain direction. On presenting that memorial, it was referred to a committee, and the deputation was informed that it should be referred to a committee, not for the sake of being got rid of, but they thought that we had made out a good case for consideration, and we were assured that the deputation should have notice, when the question was to come under consideration; but that has not happened yet.

How long was that ago?—Two years ago.

This is in the Tower Hamlets district?—Yes.

Have the inhabitants who pay sewers' rates any voice in the choosing the Commissioners?—None whatever.

Have they any control over the acts of the Commissioners?—None whatever.

Would it not be advantageous that those who pay the rates for those necessary purposes should in some form or other have some control over the manner in which the money is expended?—If they were to have some control over the manner in which it is expended, or the parties who have the expending of it, I should expect that individuals who paid so little attention to it would not be likely to be re-elected.

You think it would most likely bring in some improvement?—I think it would.

How are they elected at present?—They are appointed under the Great Seal.

Supposing that in your district you had one Commissioner elected, he would still be in a minority?—Yes.

And the majority from another district would govern the first application of the sewers' money to that district?—Certainly they would.

Is your district crowded, or are there a great many new buildings going on?—No, it is an old district.

Are the buildings rather close together?—Some of them are.

Would it be an improvement, if for the future there was some rule, so that the streets should be wider, so as to give a better circulation of air?—It would be an improvement if it could be effected without injury to private property.

Do you think some regulations as to having decent privies or water-closets, and places for the reception of refuse, would be advantageous to the health of the inhabitants?—very much so. Some of the places are very bad indeed.

Do you think, from your knowledge of those localities, that some regulations for the better enforcement of drainage, and cleansing and sweeping would be very advantageous to the inhabitants?—I think it would.

Have you read the statement of Mr. Little?—I have.

Are any of those facts applicable to your own district?—I think that is peculiar to a new district; what I am speaking of principally are old districts.

Mr. Charles
Bratt.

Do you think it would be practicable in old districts to open out masses of buildings, which are too close together, without doing any violence to the rights of property?—If it could be done without doing violence to the rights of property, it would be a great improvement.

Supposing a narrow court is built up at the end, do you see any objection to opening it at the end, making reasonable compensation to the owner of the property?—If reasonable compensation is made to the owner of the property, it would be a very great benefit.

Do you happen to know what is the amount of loss of rent caused only by sickness in that district. Is not it considerable amongst the poorer and worse-conditioned population?—Sickness at all times forms an excuse for the poorer part not paying their rent, and a reasonable excuse.

Is not the loss from sickness very considerable in those worse-conditioned tenements?—I believe, in some of the districts which have been referred to, there is perhaps no period of the year free from fever.

Do you think the poor-rates in your district are very much increased owing to illness, referable to these causes?—No doubt.

And that good structural regulations and additional supplies of water, and better cleansing and drainage, would be good economy in respect of poor-rates?—I certainly think it would.

Have you any open spaces reserved near you for public walks, or anything of that kind?—Nothing of the kind.

How far are you from the Victoria Park, where it is understood that there is a reservation made now?—Two miles.

Is it your opinion that, owing to the crowded state of the buildings, and the absence of any open space for exercise, the people are very much led to bad habits?—I should think, if there were open spaces of ground, it would frequently lead persons to them rather than to public-houses.

It is stated that the loss on the collection of rent from the poorest class of tenements is, in ordinary cases, about 15 per cent., of which about one-third would be, in ordinary times, the loss from sickness, and the rest from loss of work and fraud; do you think that is correct as far as your neighbourhood is concerned?—I think that is about correct.

The loss from sickness being the loss from the sickness of the head of the family chiefly, and his consequent inability to pursue his work?—Yes.

What is the expense of a supply of water generally?—A guinea, in a small house.

How many families in a house?—I should say two. The guinea would be for the supply of a house with four rooms in it.

For what period do you have a supply for that money?—Three times a-week, two hours each time.

In case of the occurrence of fire, how long have you usually to wait before the water can be brought to the fire?—I do not think

we have a right to complain a great deal upon that ground; the water is generally pretty ready in the district I allude to.

Do you know the district of Wentworth-street, Whitechapel, and the courts that branch out of it?—Yes.

Do they remain in the same state of filth and dirt in which they were a year ago?—Yes.

Do you know anything of the state of the low lodging-houses in that district?—From the relieving officer of our district I have heard a good deal.

Have you heard that they are in a very neglected, wretched state?—As wretched as it is possible that they can be.

Is there any authority to visit them, and to enforce their being washed and ventilated, and cleansed?—There is an Act of Parliament, that has been passed within a short period; it has been frequently brought under the notice of the Board of Guardians, and notices have been given; and in some instances I believe there has been a little cleansing on that account; but it is only temporary.

Do persons of the worst character keep lodging-houses in that district?—They are not the best, that is certain, or they would not keep lodging-houses.

Those lodging-houses are resorted to by a migratory and changing population of a very low character?—Yes, very low.

Do they require, in your opinion, supervision and cleansing from time to time?—They do.

Does not the whole district about there, which is thickly populated, require great improvement as regards the health of the working classes?—Very great. That district, beginning at Wentworth-street and going on, with very little exception, to the back of Shoreditch church, is as bad as any that can be found.

Are you acquainted with a district, not very far from that, between Shoreditch church and Bishopsgate Without, crossing Bishopsgate-street Without and going into the small courts near Half-Moon-street, Sweet-Apple-alley, and a number of alleys branching from there?—Yes.

Is that a district that is extremely populous?—Yes.

Do you know that that also is a neglected and filthy district?—The City of London are at this time very busy in carrying sewers through that district.

How long have they begun upon that good work?—I think they have been upon that work very busy for the last ten or twelve years—not just in that district.

Is not it about a twelvemonth that they have been so employed in that district?—Yes.

How long have you known that district?—I have known it these fifty years.

During all the time you have known it till within the last two or three years, has it been a very neglected and dirty district?—Yes.

Mr. Charles
Bratt.

Do you know 'Thompson's-rents'?—Yes.

Do you know the inner court beyond that called Thompson's-rents?—I used to know it twenty or twenty-five years ago.

Do you know Sweet-Apple-row and Catherine-alley?—Yes.

Is not all that district one which stands in great need of cleansing and drainage?—Yes.

Is not that a part in which the cleansing and scavenging is greatly neglected?—Not quite so much as some of the other districts I have mentioned.

You mean that it is not quite so bad as those courts out of Wentworth-street?—No.

There is a district called Spitalfields-market?—Yes.

Do you know whether the cleansing of the refuse from that market is attended to?—It is not.

Is not it requisite that some improvement should take place in that?—It should, I have heard a good deal of complaint of collecting the refuse in Spitalfields-market, and leaving it for a day or two, that carts might take it away for manure, creating a very offensive smell.

Petticoat-lane, does not that also require some cleansing?—Petticoat-lane within the last three years has had a new sewer laid down in it.

With respect to the scavenging, how is it?—It is filthy, but not so bad as it used to be.

In the dirty neighbourhood, on the west side of Bishopsgate-street, where those close courts are, the paving and scavenging, and sewage is under the authorities of the City of London?—Yes.

In the district you spoke of first, in the Tower Hamlets, under whom is the paving?—It is under small commissions.

In the case of the districts that have been referred to, is not it almost impossible for a decent family who come there to keep up their decent habits, is it not almost certain that they will come down to the low habits of their neighbours?—I should say it is almost impossible for them to maintain decent habits; but in reference to a part, at the back of Shoreditch church, there are some streets that were formed about 30 or 40 years ago, inhabited in stories where the cellars are inhabited as dwellings, without any sewage whatever.

Is not it highly necessary that such a practice should be put a stop to, unless there is an area and proper drainage?—Yes.

What are the names of those streets?—Collingwood-street, Nelson-street, and Vincent-street.

What is the price of a night's lodging in some of those lodging-houses to which you refer?—2*d.*, 2½*d.*, and 3*d.*

Are there none lower than that?—Yes, I suppose there are.

Do you know whether there are many people that sleep out all night in that district?—We have representations frequently, of persons being out all night and sleeping on staircases.

Is there any particular haunt that is accessible to people at night, but still protected in the shape of an arch or gateway?—— Not that I know of. It frequently happens that when poor people are before the Board of Guardians, the question arises where they slept the last night, and it takes a great deal of trouble to ascertain where they did sleep last, either in a bed or room.

Mr. Charles
Bratt.

Are you aware that a considerable number of people do sleep out of doors?——Yes, but there are many large houses that let out lodgings, and the consequence is, that the street-door is never fastened, and after most of the inmates have retired, these poor persons secrete themselves upon the staircase. I apprehend that is the sort of place they mostly go to.

STRETHILL O. FODEN, Esq., Architect, examined.

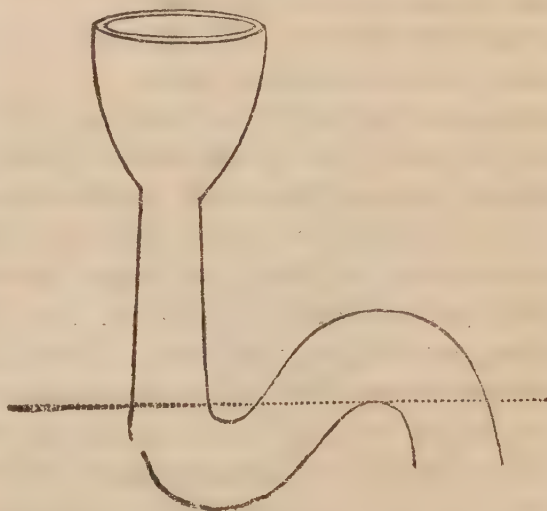
HAVE you been engaged in superintending the building of work-houses and other edifices for the reception of persons of the labouring classes?——Yes, I have. I have superintended the erection of the Rye Union-house, the Aylesbury Union-house, and other similar buildings.

Strethill O.
Foden, Esq.

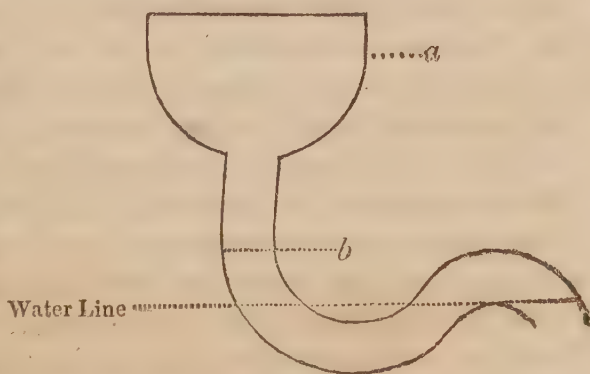
In the course of such practice have you had occasion to pay especial attention to the means of superseding the use of privies and cesspools by the substitution of soil-pans, and simpler and cheaper apparatus than the common water-closet?——Yes, I have. I have been at great pains to examine the various methods now in use for the purpose in question. I have paid particular attention to the apparatus which is in successful use in 500 rooms in one public establishment. In various private houses, soil-pans with traps are in use on one common principle. A soil-pan of the description displayed [No. 1], made of lead, has been in use 18 years in a private gentlemen's house; and is found to act very well.

The following [No. 2]

No. 1.



No. 2.



Stretbill O.
Foden, Esq.

is the form of a soil-pan and trap made of iron which has been in use in several hundred instances. The objection is to the material, which is of cast-iron, which in time corrodes. The filth is then apt to adhere to it.

Another form is the following, [No. 3] sold by Mr. Wiss, of Charing-cross, which possesses advantages for places, where it may be difficult to get height or room. The top is of earthenware, the bottom portion is of lead.

What do you deem the most advantageous and convenient form of apparatus?

—The form represented in the subjoined diagram [No. 4] would, I think, be found to answer the best for common tenements. C. is a sink and soil-pan; the

dotted lines showing the form of the pan and the trap which is connected with the house-drain, which leads to the sewer or main drain in front of the house. This soil-pan may be made of two pieces, or formed in one block, and glazed inside. The flap or seat B. may be hung on hinges to a wood frame, that it may be lifted, and vessels be emptied into the sink or trap C. without wetting or dirtying the seat. The lid A. falls down within the wood enclosure, and gives the whole a neat appearance. If made in one block, it might be in a round form.

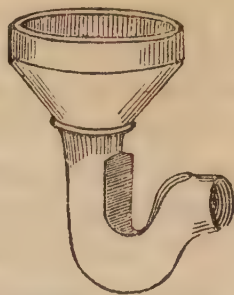
What might be the expense of this apparatus?—That would depend on the number used. But the price might vary from 25s. to 30s. each, including the price of fixing them complete.

What would be the expense of the water-pipe and tap if a great number were done?—A moderate length of pipe, with a tap, to supply a soil-pan and small sink, would cost about 15s.

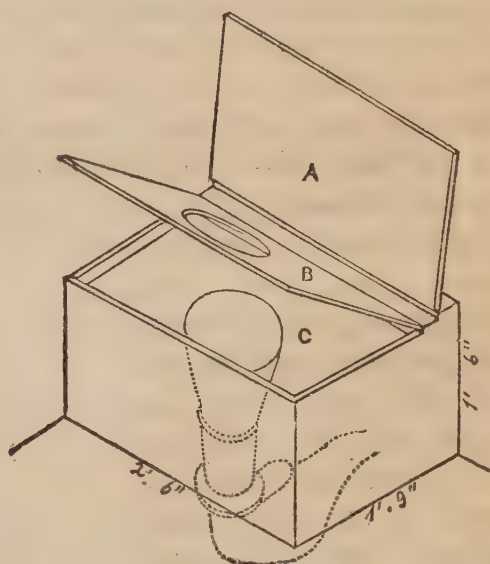
What would be the expense of the sink?—A small sink with waste pipe, grate, and tap, would cost about 25s.

It is stated that at Huddersfield and other places the use even of the cheaper water-closets has been introduced among the labouring classes, and that at Glasgow, in new houses built for the working classes, the use of soil-pans has been introduced. Have you sufficient experience in London to justify the conclusion

No. 3.



No. 4.



that a similar apparatus would be acceptable and available for houses of the poorest labouring classes?—Yes, in Cross-street, Hatton-garden, a house has been let as a lodging-house in separate floors and separate rooms, to people of the working classes; there are six or seven families in the house; this house has been recently repaired, and one pan has been fixed in a part of the premises for the use of the whole house; there is a cistern on the top of the privy; the bricklayer, a man of the name of Prime, in St. John-street, Clerkenwell, informs me that it “answers most admirably.” These are his words. He proposes to find the pan and fix it complete, and connect it with a drain in any old tenement in any part of the London district for 1*l.* each, privy superseded. The laying on the pipe would be extra, and it would be a varying charge, according to the distance of the supply. From this experience he has purchased several of these pans to fit up in other places in the same neighbourhood, which is chiefly inhabited by the poorer classes.

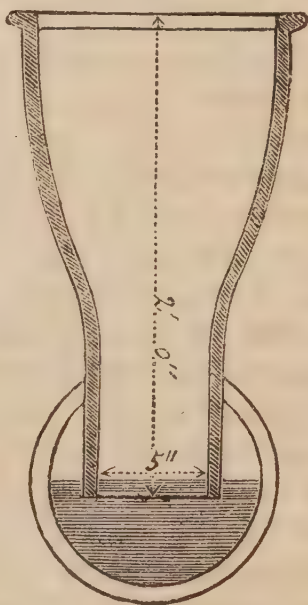
Where there exists any common privy, and when a constant supply of water at high pressure may be obtained, do you think the principle of the soil-pan you have described available in that or in any other form?—Yes. The soil-pans I have described I have used for the inside of houses; for the outside I have used pans of the annexed form [No. 5]. The pan and pipe is in one piece—set to dip into the water which stands in the drain, means being provided to flush it out occasionally. This would do admirably where a running stream could be made the means of flushing.

What is the common expense of digging and forming a cesspool?—Digging and “steining,” that is, lining it with brick, is from 1*l.* 10*s.* to 2*l.*

Would that be the expense of the cesspool to a common privy for a fourth-class house, such as would be occupied by labourers?—Yes; that would be the expense for such a house.

How much addition to the rent would the construction of such a cess-pool involve?—At 8 per cent., which is the lowest charge, it would be from 1*s.* 3*d.* to 1*s.* 6*d.* per annum: it might fairly be put at 2*s.* per annum for such tenements where, for the risk, they require 10 per cent.

No. 5.



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This, however, is for a cesspool which does not prevent the contents permeating the surrounding stratum?—No; they are built up with dry brick-work, that is, brick-work without mortar.

In what state do you usually find the old foundations in taking them up?—We find the earth around it usually saturated, and springs near are poisoned with the soakage from the cesspool.

Is it not commonly injurious to the foundation?—Decidedly so; and in some places it rots the floors. In taking up old foundations the soakage is often found to be very offensive.

What course is usually taken to obviate these evils?—We line the cesspool with cement, and provide an overflow drain from them into the common sewer or the nearest outlet.

What would be the extra expense of such a protection for a common privy?—It would cost 1*l.* more to line it with cement. Then either the cesspool must be more frequently cleansed, in which case there is an extra expense incurred, as indeed there would be even if an overflow drain were provided. The expense of an overflow drain would be uncertain. In the usual mode it would be not less than 1*s.* 6*d.* per foot, and not less in distance than 30 feet. It would be probably 50 feet. The additional expense of a cesspool so protected, 3 feet 6 diameter, would not, at the London prices, be less than 3*l.* 5*s.*

Making the whole expense of the cesspool so protected about 5*l.*, and involving an annual rent, at 10 per cent., of 10*s.* for the cesspool alone?—Yes; that would be about the amount.

Nightmen and persons carrying on the business of cleansing such receptacles have stated that the expense of cleansing cesspools, if properly done, will involve the labour of emptying and the expense of carting away two loads of such refuse, or an expense, one tenement with another, of 1*l.* per annum each, in the metropolis; and in other districts, where the refuse is in higher demand as manure, the expense of that emptying and the cartage of two loads, whatever it may in the particular district be, is deducted from the saleable value of the manure. This expense of cleansing, added to the rental of the cesspool, on your estimate, then, make the present annual charge of that mode of cleansing in the metropolis from 1*l.* to 1*l.* 10*s.* per annum; or 1*l.* 2*s.* per annum, or from 4*d.* to 5*d.* per week, for common tenements. Now, if the use of the cesspool were generally superseded, and soil-pans and such apparatus as you describe were laid on in new or in old tenements, in connection with the public drainage, and as part of it, executed under a general contract, involving an additional rental of 5 per cent. on the outlay, what would be the common expense per week per tenement—say first for a new building?—The expense will be—

	<i>£.</i>	<i>s.</i>	<i>d.</i>
For a soil-pan and curved trap, such as described in the sketch, 1 <i>l.</i> ;			
laying on the water with 8 feet of $\frac{1}{2}$ -inch lead pipe, and a stool-			
cock, will be about 10 <i>s.</i> ; total		1	10 0
5-inch glazed tile tube pipe, to connect with the soil-pan or sink,			
say at 6 <i>d.</i> per foot—say 30 feet		0	15 0

	£.	s.	d.
The expense of the tenant's communication water-pipe, supposing the water laid on the premises, would be, complete, about.	1	0	0
If the house were in a court, tube drains of 10 inches or 1 foot diameter would suffice, laid down at an expense of 1s. 6d. per foot, to serve the houses on both sides, say 18 feet frontage, or 9 feet for each, with a tile trap at the entrance	0	15	0
Total	4	0	0
Involving for the repayment of principal and 5 per cent. interest, by instalments in 30 years, a rental of	0	4	10
Or, a weekly rent of	0	0	1 $\frac{1}{4}$

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I presume that water is to be laid on, and the house and main drainage is to be done under the public authority, when 5 per cent. would suffice. If the work be done separately by private individuals, it would be at the common rate for building work of that class, that is to say, 10 per cent., occasioning a double rental to the occupier.

It is stated in evidence that water may be provided and laid on upon the smaller tenements, at constant pressure, night and day, so as to supersede the necessity of water-butts and tanks, and any expense of such machinery, as is now done at Nottingham at an expense of 4s. 6d. per tenement, or 1d. weekly. The total weekly charge for the improvement would therefore be as follows or thereabouts:—

Rental for apparatus	d.
For water	1 $\frac{1}{4}$

Total per tenement . . . 2 $\frac{1}{4}$ per family weekly;

or less than half the existing charge of the present noxious system?—Supposing water to be had at the price stated, this change of system may undoubtedly be accomplished for the above sum.

Supposing it were requisite, in any large number of existing houses which had only cesspools, and had no drains to supersede the cesspools and lay down soil-pans, and house and street drains in them; what do you consider would be the extra expense of such a process?—I believe that 1l. per house would cover all the additional expense above the expense stated. The additional expense would be of cutting through two walls, taking up and re-laying flooring. If it were done under a contract, no doubt 1l. per tenement would cover the expense: there would be little more than the additional labour.

That, then, would involve an additional rental of 1s. 2 $\frac{1}{4}$ d. per house per annum, or, per week, of $\frac{1}{4}$ d., making the total weekly rent of the new apparatus applied to existing buildings 2 $\frac{1}{2}$ d., or half the existing charge, and bring water into the tenement into the bargain?—Yes, certainly.

Do you consider that if the whole change were carried out, under public authority, in the manner indicated in the form of a supposed notification, it would be generally acceptable to

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landlords as well as tenants: is there any doubt that they would appreciate the advantages in the reduction of mere money charges? —If it were carried out under competent authority, I have no doubt it would be appreciated. I can state this as a person interested in property in small houses such as require the relief. The bricklayer who is providing the soil-pans informs me, that he finds the builders and owners of small houses exceedingly well disposed to receive them, as being so superior to the common privy, and being as effectual at a low charge as the usual water-closet apparatus. For the middle classes of persons, the existence of a water-closet is supposed to give an additional value to the house of 5*l.* per annum, and I am quite confident, from my own experience in London, that it does so.

For middle class houses all that need be added to the estimate of the additional expenses of the removal of existing cesspools would be the expense of a second class sewer, which it is stated may be made at 3*s.* or 4*s.* per foot: on the subjoined answer to the following question to Mr. Hawksley:—"Do you consider that the sewage of towns may be improved in general construction, and rendered more economical?—Yes; by the use of egg-shaped sewers, built with radiating bricks. I find an egg-shaped sewer, 2 feet 9 inches high, and 2 feet wide, may be laid at a depth of at least 8 feet for about 3*s.* per foot, the bricks radiating, and the rim 4½ inches thick. Such a sewer would be large enough for two-thirds of the streets of a provincial town, if the inclination be not less than 1 inch in 10 feet. Such a sewer would frequently drain 500 or 600 houses, and would relatively answer the purpose of second sized (4 feet 6 inches by 2 feet 6 inches) sewers in London. Staffordshire drain-pipes, of 10 inches diameter, would answer for most courts." Do you agree in this view?—Yes, on a 20 feet frontage for this class of houses, the expense of 10 feet of the new sewer, where they require it, would be 2*l.* each house, or a rental of 2*s.* 5*d.* per annum. But most of that class of houses would not only have some sewerage, but would have a supply of water laid on.

Do you doubt that if water can be laid on constantly at high pressure, it will be proper to prohibit entirely the use of cesspools in towns, and to compel the use of more economical, as well as more effectual and salubrious means of cleansing?—There can be no question of the propriety of such a course of legislation.

It appears, then, from your evidence, that you put down an apparatus of the nature of a water-closet, with water-cock and pipe, sink and drain in the house, in a new district, at an expense of 2*l.* 5*s.*, or only 3*s.* more than a surveyor's fee for seeing to the erection of a party wall to a two story house in an old district; that an expense of 4*l.*, or not much more than the surveyor's fee for a first class house in an old district, the public may, in a new district, or a provincial town, defray the expense of the complete apparatus of

the nature of a water-closet, the sink, and improved house drain, the expense of the tenants' communication water-pipe, and the proportionate expense of a second class sewer?——Unquestionably.

Supposing the house and the main drainage to form in a new district part of one general system, under the superintendence of a competent officer, who has to see that all drains are proper and efficient, might not that officer, who has to see that the drains are properly laid, at the same time, and without any heavy addition to his general duty, see that the foundations of any party wall which might be required is properly laid, and the necessity be obviated of giving a fee for taking a professional man out of his practice, chiefly for the one special object of seeing to the sufficiency of a party wall?——I think that the two duties might be combined with great advantage.

Have you read the hypothetical form of a notice for the formation of such works in new or in old districts mentioned in the evidence given by Mr. Biers?——Yes, I have.

Do you consider that the principle, if carried out, would be acceptable?——I conceive it would be a great boon; and with such options as it gives, entirely unobjectionable.

The cases hitherto brought under your consideration have been cases where there have been house-drains; where, it is supposed, there are main-drains or sewers, into which the house-drains may be led; and where the preservation of the refuse for agricultural purposes has not necessarily entered into consideration. Have you had to meet cases in rural districts where there have been no main-drains or system of public sewage?——Yes, I have. In the case of the Union workhouses at Rye and Aylesbury, soil-pans were fixed at the instance of Mr. Parker, the Assistant Commissioner. Where the situations have been favourable, as at Rye, for giving a rapid fall to the drain, I placed a large covered tank or cesspool at some distance from the building: the tank was formed for the preservation of the refuse, and its application to agricultural purposes as liquid manure. It would be pumped into water carts, and in that mode distributed as liquid manure. In one instance of some land manured by the liquid manure applied by water-carts, the produce of the land was stated to have been doubled.

In the instances you have mentioned, did you succeed in preventing any smells?——Yes, completely; at Rye, the tank was 200 feet or more from the building.

By this apparatus, then, would be conveyed away not only the soil, but urine, which is of high value as manure, but generally allowed to run away to waste?——Yes; everything was carried away from the building.

And the night-soil being carried away in suspension in water through covered and impermeable drains, and received into covered and impermeable tanks, there was the less escape in the form of ammonia, in which it is stated, that two-thirds of the fertilizing value

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of that manure is usually lost by evaporation, to the injury of the public?—In this mode there was certainly no smell, and I do not believe there would be any considerable amount of evaporation. It could not escape either through the drains or the cesspools.

How were the tanks formed?—They were formed circular, with a dome top, and a hole to get out the liquid manure with a cover stone. The sides were built in mortar simply.

Has any rule been deduced as to the size of such tanks in proportion to the number of inmates of the tenements drained?—I am not aware of any such rule myself as having been yet formed.

It is stated, that cheap tanks for the reception of liquid manure have been formed simply by common stones (where they were to be had) puddled with strong clay: and a top formed of loose timber, covered over with strong thick turf, which are stated to act very well. Have you met with such instances?—I have not; but I have no doubt they would act well.

What number of inmates was the workhouse at Rye calculated for?—When completed it will hold 500.

What was the size of the soil-drain?—A fourteen-inch barrel drain, smooth, the bottom cemented perfectly, and the top built in mortar.

If you could have got them, would not proper tile tubes, of a foot or 14 inches in diameter, have served as well, or better?—Yes; they would have been better, if such tile drains as I should have used for such a purpose, the Staffordshire ware, could have been had readily.

Such an arrangement being advantageous for such an edifice, would not an arrangement similar in principle, at the least, be equally available for a detached suburb, or a village containing the same number of inhabitants, provided they have a sufficient supply of water?—No question of it.

What would be the expense of the barrel drain, such as you constructed in the particular instance?—2*s.* 6*d.* or 3*s.* per foot.

What would a pipe drain of Staffordshire tile tube cost?—About 1*s.* 6*d.* per foot.

It appears from the evidence of Mr. Braidwood, and from other sources, that fires very rarely occur in the tenements occupied by the labouring classes; that in the metropolis, for example, only 1 out of 700 fires occurred in tenements occupied by the labouring classes; the chief reason assigned for which is, that their rooms are generally always occupied, and whenever a fire does take place, it is at once put out before it gets head. Now, in respect to this class of property, do you consider legislative protection necessary for the enforcement of party-walls between every two houses?—In respect to houses occupied by the labouring classes, I certainly think party-walls an unnecessary expense.

What is the additional rent entailed by building a party-wall for

a labourer's tenement, a two-story house in a town, in the metropolis, for example?—The extra expense of the wall is about 8*l.* each house, which, at 10 per cent., gives a rental of 16*s.* per annum beyond what it would be if there were no registration.

Is there any further loss consequent on the unnecessary space occupied by party-walls?—Besides the additional expense incurred by an unnecessary thickness of party-wall in this class of houses, the loss of space consequent on such legislation should be considered (allowing that five inches be taken for each party-wall), would take 17 feet superficial of space from each house. The extra thickness taken by party-walls from every such house is equal to the space frequently allowed for a bed, or a large sized clothes-press. Three children might sleep in the space.

The increased expense of a party-wall would then incur for each such house a weekly rent of 3¼*d.*?—Yes, nearly that.

Suppose there were no restriction on this class of party-walls, what would be the expense of insurance, taking the house and furniture to be worth 400*l.*, and not taking into account the additional security obtainable from keeping on a constant supply of water night and day, at high pressure, in constant readiness for application to extinguish fires?—The common insurance, including duty, is 4*s.* 6*d.* per cent.

Then such houses may at present be wholly insured at less expense than by the erection of a party-wall?—Yes.

It would appear, then, if competing expenses be considered, that water may be laid on and kept on at high pressure, in constant readiness for the extinction of fires as well as for domestic use; that the house may be drained and supplied with a soil-pan apparatus; and pay its contribution to a common sewer: altogether at an expense involving a rental of 2½*d.* per week?—Yes; but the additional rental for the party-wall is exclusive of the expense and additional rental incurred by the surveyor's fee.

Do labourers' tenements frequently fall in, either from failure of the walls or of the flooring, or from any other cause?—No, they fall in very rarely, though they are built very slightly in the metropolis.

Do you deem legislative interference necessary in respect to that class of houses, either in respect to secure at increased expense either thickness of walls or thickness of floors?—Certainly not. All such legislation, either for thickness of walls or for thickness of floors, I think uncalled for and mischievous, as inflicting unnecessary expense on a class of persons who can ill afford to bear it. Thick walls are unnecessary for strength for such tenements. Thick walls do not always secure warmth. I agree with other witnesses who state that walls battened are preferable to thick walls unbattened. Besides, all such gratuitous interferences stand in the way of improvements. I think that legislation should be confined to the securing house-drainage and cleansing, and sup-

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plies of water at a cheap rate. These are objects of paramount importance, and they cannot be accomplished by individuals. Something might, I think, be done by legislation to secure better ventilation, without increasing expense. It is also, I think, possible to ensure due provision for external ventilation, in respect to the width of courts and streets. But everything that does not diminish rather than increase some existing expense I think pernicious.

It appears then, from your evidence, that you put down an apparatus of the nature of a water-closet, with water-cock and pipe, sink and drain in the house, in a new district, at an expense of 2*l.* 5*s.*, or only 3*s.* more than a surveyor's fee, for seeing to the erection of a party-wall to a two-story house, in an old district; that at an expense of 4*l.*, or not much more than the surveyor's fee for a first-class house in an old district, the public may, in a new district, or a provincial town, defray the expense of the complete apparatus of the nature of a water-closet, the sink, and improved house drain, the expense of the tenants' communication water-pipe, and the proportionate expense of a second-class sewer?—Unquestionably.

Supposing the house and the main drainage to form, in a new district, part of one general system, under the superintendence of a competent officer, who has to see that all drains are proper and efficient, might not that officer who has to see that the drains are properly laid, at the same time, and without any heavy addition to his general duty, see that the foundations of any party-wall which might be required is properly laid, and the necessity be obviated of giving a fee for taking a professional man out of his practice, chiefly for the one special object of seeing to the sufficiency of a party-wall?—I think that the two duties might be combined with great advantage.

EDWARD CORBETT, Architect, &c.

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ARE you an architect in Manchester?—I am an architect and surveyor, and have some business as estate and insurance agent.

Have you also been a considerable time on the Police Commission?—I have been about six years on the Commission, and during the greater part of that time I was on the Fire Committee.

Had you, as a member of that committee, to consider the best mode of obtaining supplies of water in case of fire?—That, of course, was one object of our attention.

Were you satisfied that the mode of supply was adequate for the purpose intended?—Decidedly not. I felt much dissatisfied with the delays which occurred in procuring supplies of water for the engines on their arrival; and at one of the earliest meetings of the committee, after my election, I proposed that means should be

taken to have water constantly on in the mains ; but the proposition was overruled on account of the expense.

In what did the additional expense consist ?——It was said that an additional sum would have been charged by the Waterworks to compensate them for the water being constantly on, and, therefore, liable to be drawn off by the consumers ; to meet which additional charge there was no fund available by the committee.

Are you aware that, by the experience of Preston, Ashton, Nottingham, and other towns in which water is constantly on in the mains, an actual saving of water is effected by this very circumstance ?——I was not then aware of it, but since that time I have become so.

Have you read the evidence of Mr. Anderton, of Preston, and of Mr. Bradley, the manager of the fire brigade in the same town, for extinguishing fires, and also the evidence of Mr. Hawksley relating to Nottingham, and the answers to the questions received from Philadelphia and New York, stating the results of having a constant supply of water in the mains night and day at high pressure, to be applied at once by means of a hose, and thrown over the premises, if necessary, to extinguish fires ?——Yes, I have.

If such a system had been available since you have been a member of the Fire-Engine Committee, what amount or proportion of loss from fire do you think might have been saved to the town ?——I think it would be fair to estimate that one-half of the losses by fire would have been saved. I am not prepared to estimate that saving with great accuracy ; but I feel very confident that it would have been upwards of 100,000*l.* during about seven years.

Does the construction of the warehouses in Manchester render them peculiarly liable to destruction by fire ?——Very much so. The general fashion of forming warehouses has been to build them with wood-bearers and beams supported on cast-iron columns, brick outside walls lined with wood, painted and varnished, with a well for hoisting goods through every floor, these wells being formed of wood. They have a large space for light, from the top to the ground-floor, open through and serving as a funnel in case of fire ; the counters surrounding the wells being backed with varnished wood-work, forming a supply of fuel, and the windows being so many air-draughts to supply the air requisite to cause the whole to burn in the shortest possible time.

Then, with such a form, it must be of the first importance to have an immediate supply of water ?——Without an immediate supply the efforts of the most skilful firemen will, in most instances, be useless in saving the building on fire, and can only be directed to prevent its extension, which is often a difficult task, from the extent of the buildings in fire connection, and the narrowness of many of the streets.

Do you consider it practicable to build warehouses possessing similar advantages to those now existing, but less exposed to risk

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of destruction by fire?—Certainly. They ought to be built with well-faced brickwork or masonry, instead of the wooden wells, the walls and ceilings being also of brickwork; care being taken in the arrangements for gas-light, warming, and ventilation, so as to diminish the risk of fire from these sources.

Do you consider that warehouses should be separated by party-walls?—Yes, certainly so; for when we come to calculate the relative cost of insurance and fire-fencing construction, as applied to warehouses and buildings destined for the reception of costly goods, the expediency and economy of constructing such walls and fire-fences is very apparent. Suppose we take the case of a warehouse five stories high, 16 yards deep, and 10 yards wide, we have a cost of about 1600*l.* on the building to ensure at a rate of nearly 3*s.*, say 2*s.*, per cent. additional,* = 1*l.* 12*s.*; goods, value perhaps on average 10,000*l.* at 2*s.* = 10*l.*; total saved annually, 11*l.* 12*s.*; and as the cost of the wall is not increased, because the requisite thickness for a fire-fence is also requisite for strength, we have only to add that 2 feet high above the roof, 1½ brick in thickness, 16 yards long, at 3*s.*, = 2*l.* 8*s.*, and 16 yards of coping and flashing, at 3*s.*, = 2*l.* 8*s.*; total outlay, 4*l.* 16*s.*; the interest on which is amply covered by the saving on the building alone. There is little doubt that the present defective system would find its remedy, even without legislative interference, by the rates of insurance rising and acting as a check on it. But still much mischief must arise in the mean time: many offices even now refuse to take the risk.

Fires are stated rarely to occur, and seldom to extend in cottage property, and as the cost of a party-wall for a cottage might be about 30*s.* to insure against an accident which seldom happens, might this sum not be better applied in laying on water at high pressure, which would afford a means of checking fire in the house itself, and add additional facilities for cleanliness?—In higher class houses I think party-walls should be retained, because the expense bears a much less proportion to the cost of insurance than when applied to the lower class dwellings; but in the lower class dwellings, the expense might be better laid out towards supplying water and water-closets. The annual cost entailed upon the tenant by a party-wall above the roof would be about 3*s.*, and if nine inches thick, about 4*s.* 6*d.* The cost of laying on water would be 10*s.* The rental on 10*s.*, in addition to the annual charge for water, would, according to the present rates of this town, be about 8*s.*, which would be well laid out in the promotion of cleanliness and health, and would be valued by the occupants generally, who would much rather pay 8*s.* for an abundant supply of water than 4*s.* for a party-wall.

According to your calculation 8*s.* per annum would cover the expense of laying on and supplying water where it does not already exist, which is equivalent to an addition of about 3*s.* per annum to the present rates which the poorer classes pay for procuring

* Since much increased.

water from stand pipes ; now it has been shown that a water-closet for such tenements may be fitted up at an expense of 3*l.*, or at an annual cost of 4*s.*, making an additional total cost of 7*s.* on the rental for a water-closet, and a better supply of water to each house, do you think that this additional cost on the poorer dwellings would be well incurred?—Decidedly so ; the advantages of the system would be soon appreciated, and the poorer classes would generally very much value the improved system on account of its increased cleanliness, decency, and convenience.

Do you conceive that there would be much risk of wanton damage to the apparatus?—It would be of importance in the worst districts of the town to have the piping of iron, or some other cheap material. But I do not anticipate any damage to the apparatus, except insofar as the want of experience might at first operate in producing unintentional mischief, but such would be of as little consequence as the breakage of street lamps in comparison with the advantages of gas-light.

In respect to dwelling houses for the poor, if a general system of water-closets was introduced, and a sufficient supply of water connected with sewerage, do you consider that there would be much objection to the expenses incurred by such additions?—I have no doubt of the expediency of providing a good supply of water under sufficient pressure for the purpose of street and sewer cleansing ; and I am also convinced that great advantages would result from the introduction of the water-closet system. There might be a few prejudices to encounter at first ; but I am assured they would be dissipated by the experience of a year or two in the benefit and general good economy of the system. No tax would afterwards be more willingly paid than the amount requisite to reimburse the outlay. But the repayment of the outlay should be distributed over a period of 20 or 30 years, for, from the peculiar way in which many become owners of building property, there is abundance of need to be careful in imposing burdens on them.

Have you considered the best means, in the event of the introduction of the water-closet system, of applying the refuse of a town for manure?—For this town I would suggest that a large depôt be formed in the manner of a covered well, and that the sewerage of the town should be carried into it by a system of main sewers placed in the direction of, and under the general line of the rivers and brooks forming the natural drainage of the district ; that the present sewer-mouths should be dropped into these drains ; and that the contents under the large covered well should be lifted to a considerable height, and sent into the country by pipes laid in the general lines of the navigation, say on the reverse bank from the towing-paths. Means should be provided at the crossing of roads for charging country carts with the liquid manure ; by which means it could be conveyed in a cheap, efficacious, and economical manner, without the present nuisance of foul rivers and putrid canals, or roads, as in some

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directions at present existing, lined with a continuous stream of dung-carts. The garden produce of these districts would be brought into the town; and the system of taking out the refuse would be cheaper than the present system, and free from the nuisance.

It appears to me that the low lands near Oardsall or Trafford Moss are well suited for the placing of the lifting pump and receiver, and it is easy to construct the sewage drains in such manner that, on the occasion of a heavy rain or flood, the rivers should take the superabundant water as at present.

The cost of this undertaking, I believe, would be compensated by its income, together with the sanatory advantages of removing the nuisances before mentioned, and the saving of cost of scavenging in part. I am not prepared to say accurately what would be the cost as the calculation would involve the outlay of more time than I can afford to give. I have thought of it, and of all the objections I could find; but all were trivial in comparison of the benefits to be received by the adoption of the system.

How do you obtain in Manchester and Salford the necessary funds for sewerage and paving unimproved districts?—Ultimately from the owners of property situated in the districts improved. The expenses are considered to be due as soon as the work is finished.

Does any inconvenience arise from this system?—It is frequently very oppressive, especially to the owners of cottage property. I have known instances from which two to four years' rent has been required to pay the charges for paving and sewerage. Of course where the income of the owner arises from the property alone, the case becomes extremely oppressive.

If the payments, instead of being demanded at once, were reimbursed in equal annual instalments with interest over an extended term of years, would this mode be an equitable and popular one of reimbursing the outlay?—It would be a great improvement on the present system, and, if spread over a term of 20 years, would scarcely be felt; but the owner should have the option of paying the expense at once if he choose.

Would such a mode of levying the expense remove the principal objection to the improvement of ill-conditioned localities?—Decidedly so; it is my belief that it would cause the improvement of such localities to be earnestly sought for by the owner.

The air in the houses of the poorer classes is generally in a very unwholesome state; do you think dwellings could be better ventilated at small expense?—The adoption of a proper means of ventilation for public and private buildings is of great importance; the chief difficulty is first to give a sufficient idea of its importance to those who are yet ignorant of the subject, and to adopt a system which should be free from objection as to producing too much ventilation in stormy weather or high winds. This should be done on the principle of allowing the air to come into the rooms by a much larger orifice or orifices than the aperture for its exit, and by providing a valve

on the principle of the self-acting flood-gate, to prevent sudden puffs of wind; and to provide at the roof exit a hooded funnel, so contrived as always to turn its vent in the direction of the wind, and to have a similar valve near its orifice, so that, in case of a reverse draught by any change of wind or derangement of the apparatus, no harm would ensue. The valves should be perforated, to allow a lessened action when they close. In providing ventilation for new buildings, the work would be easily managed; and generally it is easy to adopt a cheap and efficacious method of ventilating existing buildings. The valve I have mentioned should be a disk of wood or metal, hung on pivots in its centre of gravity, but formed broader on one side of the pivots than on the other, and so weighted as to have a bias tending to keep it open, except in case of a reverse draught of wind, when, by the action of its broader side, it would shut it.

It has been suggested, that in lieu of window-tax an equivalent revenue might be obtained to Government by levying the tax on the cubic contents of the house, on the assumption that each house requires a certain amount of light and air; do you consider that this mode of charging the window-tax, while it occasioned no loss to the revenue, would operate favourably by promoting the access of light and the facilities of ventilation to the dwelling-houses?—I consider that it would be a very great benefit, and a more popular and equitable system of charging the tax than that at present in operation. It would render light and ventilation more easily attainable. The poor would have the benefit of this arrangement by making the line of exemption from the tax, at such a standard as will suffice for a working man's comfortable residence, instead of the present mode of fixing a minimum number of windows. The poor man's cottage would thus have as many windows as were requisite. I conceive that such a system would be highly advantageous to all parties.

Do you consider the local authorities to be the proper power to appoint the officers to have the control of the sewerage and laying out of streets and sanitary regulations for towns and populous districts?—I think it much more advisable that the responsibility of the district surveyors and sanitary officers should rest with a national board of public works; for, setting aside the tendency of local interests swaying such bodies, I think the fact of such offices being liable to change, greatly prevents their efficacy, the parties being often chosen irrespectively of their possessing such knowledge as the subjects require. And there is in the centralisation of power the great advantage of centralization of information and knowledge, which renders such placing of responsibility highly beneficial. I would instance the Registration Act, and the new Poor Law, out of which we may say the present inquiry has arisen, in consequence of the focalizing of information on the causes of poverty, disease, and death; and it is manifest that the utility of the best constituted local powers could not have led to such

Mr. Edward
Corbett.

valuable results, or given materials for such an accumulation of knowledge as these Acts have produced, unless there had been a point of union for their various branches of information. And from these facts and experiences, and my own ideas on the subject, I should think it much more proper that the officers should be appointed by a central board, and act under its control. I have read Mr. Holme's evidence, which I think is very generally applicable to Manchester. I quite agree with him as to the necessity of a central control, and his description of the necessary qualification of a district surveyor quite coincides with my own views.

Mr. Joseph Kaye

Mr. JOSEPH KAYE, Builder.

How many houses have you built in Huddersfield?—I believe that I have built nearly one-third of Huddersfield.

What number of men do you employ?—I now employ about 250; at other times I have employed about 1,100 men.

Have you observed the mode in which other towns are built and new houses erected?—If there had been a Building Act in Huddersfield it would have been of great advantage to the town; that is, if it regulated the drainage; if it regulated the cleansing of the towns, in respect to the privies. All the town here belongs to one landlord, Sir John Ramsden, who compels the formation of wide streets, and the building of good straight houses. I think it would have been well for other towns to have had regulations as to the width and directions of the streets. I think provision should be made for having areas in the front of houses, as it tends to keep them dry.

Are the smaller houses in Huddersfield built with party walls?—The walls are usually built a brick in length, that is, 9 inches in thickness.

Have you ever found fires extend through the walls?—No, never have. A fire took place in the next house to mine this morning; it is a grocer's shop, and a large quantity of paper there had burned very rapidly, and consumed the whole of the things in the shop before it was put out, but the fire did not extend to my house at all. I have heard of fires extending from house to house in other towns, but not in this.

Do you conclude that it is not requisite to provide in respect to this town for the building of party-walls for protection against fire?—I certainly conclude not; there is no occasion to make the houses more than a brick in length in thickness.

Do you find that fires are very frequent amongst the houses occupied by persons of the labouring classes?—They are very rare indeed.

There appears to be a large proportion of the town where the houses are not properly drained. Suppose it to be provided that they should be drained and cleansed on a principle similar to

the water-closet, what would be the first obstacle to the accomplishment of that object?—The first obstacle would be the expense. Mr. Joseph Kaye.

If the work were done on a large scale, and under regulation, would not the persons having charge of the sewers, or other local public works, be enabled to do it not only better but much cheaper, than private individuals could do it for themselves?—I should think they might do it one-third cheaper, and certainly much better; all the little builders are quite strangers to such work.

If the persons having charge of the public sewers and drainage were enabled to raise the money for doing this by loan, and were to repay the principal and interest for the works by a rate spread over a period of years, would not such an arrangement remove the chief objections in respect to expense to the drainage of old houses?—I certainly think it would be an excellent thing, especially for the houses, which are done by working men. It is the practice in this town for working men to put into what is sometimes called a building-club; sometimes a money-club. When they have accumulated perhaps fifty pounds, they will go and build a house that costs perhaps seventy or eighty, but are unable to complete it. The drainage of these houses is particularly bad. The privies are the last things erected, and they are generally very badly done. They have no capital to get on further. In all such cases the plan proposed, which would avoid the necessity of an immediate outlay, would be a great advantage. It would be a capital thing for the labouring classes here to charge for the drainage and cleansing, and laying water on in the old houses as a rent. It would be one of the best things that could be done. I believe the inhabitants would like it. I have read the printed note on the principle of defraying such expenses, and I see nothing in it that is against my mind. It would greatly facilitate each street paying for its own sewers, which would be far better, when they were paid for as a rent, than charging the expense on a district.

It is stated that in all those houses of the labouring classes where the water is already laid on, that if it were done on a large scale a cheap apparatus of the nature of a water-closet might be laid on, with glazed pot soil-pipes to carry off all the refuse and slops from the house, and make it clean, at an expense of an outlay of 2*l.* or 3*l.* per tenement, involving a rate or additional rent of 2*s.* or 3*s.* per annum. Do you believe that the labouring classes would, after seeing the work done in some instances, so far appreciate the advantages of the additional cleanliness, and making the house "always sweet," as to be willing to pay 2*s.* or 3*s.* per annum for it?—My idea is that they would. In the areas for good houses we now put water-closets for the servants; they are becoming very common here; they are now better made and much cheaper than formerly: and the better houses, built within the last seven years, have not the smells about them, that the better houses built formerly have. The

Mr. Joseph Kaye. servants prize them very much, and they will become common for labouring men, where there is a convenience in getting into a common drain. Indeed the water-closets have been built for the servants, in consequence of the servants using those made for their masters, instead of going to their own privy in the yard. Whenever we have fevers in this town, it is generally in those places where the privies are badly kept, and where there is a pool of water stagnant, perhaps, for one-half the year.

Besides provision for drainage in any Building Bill, what other measure do you think requires to be provided for compulsorily? —Undoubtedly ventilation; it is even more important than anything I have yet mentioned. Proper arrangements for ventilation may be provided at an expense that is to be considered next to nothing. A good house may be ventilated for a few shillings. Here the poor are badly off for ventilation; they have scarce a sash or a pane that will open, and ventilation flues for cottages are almost unknown. Where people are living in numbers, the close smell you experience on entering their rooms is extremely oppressive. If the ventilation were duly attended to, I am convinced that far fewer doctors would be needed than now are. I would never have a house built, if it could be avoided, without a flue appropriated for the purpose of ventilation. I venture to say that the execution of such a provision might be very safely left to the discretion of any proper officer.

Have you ever any houses fall down, or is life endangered in this district from defects in respect to thickness of walls or floors? —I recollect nothing of the kind. Our houses are usually built with stone.

Have you had any failure of any public buildings attended with loss of life, which might be evidence of the necessity of legislation in that respect? —None whatever.

When you build cottages, do you carry up the walls above the roof, so as to protect them against fire? —We do; we carry them up to the top because it saves timber; it saves binding: the wall up to the top does not cost half so much as a binding would cost.

Mr. David
Thorp.

Mr. DAVID THORP, Surveyor to the Corporation of Hull.

HAVE you been concerned in laying out any new districts? —I laid out the South Cliff of Scarborough, which is called a new town.

What would be the expense of a party-wall for an ordinary labourer's tenement in Hull? —About eight guineas, on an average, for the whole expense of a one-brick party-wall for a common sized two-story tenement, 17 feet high, and 20 feet deep.

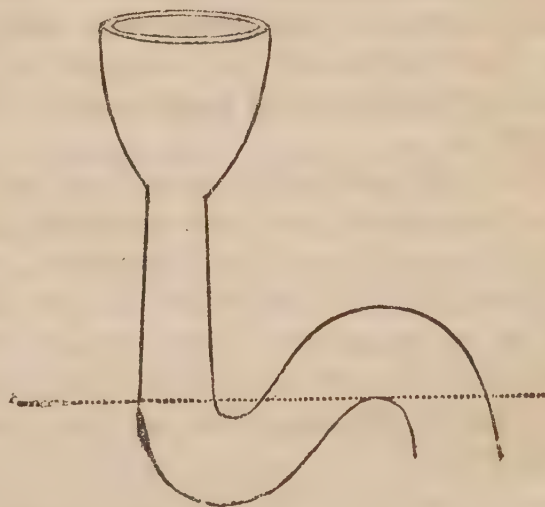
At the ordinary purchase of such property, what would be the additional rent which the erection of such a wall would incur? —Between 5s. and 6s. per house per annum.

What is the present rate of common insurance in this town for such houses as are now built without party-walls?—The common insurance is about 1s. 6d. per cent.; they would not insure such houses for more than 100l., that is about 4s. 6d. per annum, inclusive of duty.

The party-wall not being preventive of fires within the house, and only preventive of the extension of fires beyond the house, may it not be presumed from the low rate of insurance here, where there are no party-walls, that fires in houses of the labouring classes are so far unfrequent, and the extension of them still more so, as to render the building of party-walls for the prevention of the extension of fires unnecessary?—Yes. It is the practice here on building tenements to omit the gables in a row of houses erected together. I would recommend that it should be imperative on parties to carry up the same to the *under side* of the tiles or slates.

Are you aware that for an expenditure of 4s. or 5s. per annum water may be laid on in the houses of the labouring classes?—Yes; it might be through the principal part of the tenements inhabited by the labouring classes.

Do you not consider that an apparatus of the nature of a water-closet may be made so cheap as to be generally applicable to labourers' tenements?—I have no doubt of it; indeed I have had experience of it. I have constructed water-closets for the Hull gaol, which closets consist of an iron soil-pan and pipe, on the plan annexed. The soil-pan is about 10 inches in diameter, the pipe about five inches, and made of iron; the pan and pipe are joined together by what is called a bell-end, run in with lead. I am not prepared to state their cost, but if numbers were made they might be made at low prices; less than 1l. each. This same kind of closet made of earthenware may be fixed at about 8s. each. I know a person who has just fixed them at some of the lock-ups in the neighbourhood; I believe they are made at Chesterfield.



How do they act?—It is quite sufficient to prevent any smell coming into the room from the drain; and it passes the soil and everything well, although there is no regular supply of water, and only such water is used as may be put in from time to time, the soil-pan being in fact used as a sink. But it would be a proper improvement to have regular supplies of water, and then the apparatus would work completely.

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Thorp.

What would be the present price of a cast-iron soil-pipe?——
About 3*s.* 6*d.* per yard at the present price of iron.

What would be the extra expense of the soil-pan?——If there were large numbers done, it might be got for less than 10*s.* extra.

Would not strong pot pipes, luted with old Parker's cement, glazed inside, which it is stated may be had at 3½*d.* or 4*d.* per foot, answer the purpose of soil-pipes for the tenements of the labouring classes?——Yes, if they are so laid as to avoid the chances of breakage.

Will not the glazed earthen pipes have the advantage of being less liable to be oxydized?——I think they would, and that would be an advantage in their favour.

It is stated that water-cocks may be made which will admit the flow of a given quantity of water and no more; and that in case water is always kept on in the premises at high pressure, water may be so applied at an extra expense of 4*s.* or 5*s.* for the cleansing of the water-closet without the expense of a water-tank to supply a proper fall of water?——Such an apparatus would undoubtedly be a great improvement in its application to the water-closet, and would be generally adopted if it could be brought in at a low figure; such an apparatus, and stench-traps to the grates in the streets would be invaluable additions to the public health.

Have you any doubt, from your experience, that if such apparatus for cleansing could be made on a large scale, it might be introduced and fixed in labourers' tenements; and trapped communications be opened into the public sewers at an expense per tenement not exceeding 2*l.*; or if it were spread over a period of time and retained and levied as a rent, at an expense of 2*s.* per tenement per annum, or less than a halfpenny per week per tenement, or where there are two families, a halfpenny per family?——I have no doubt of it; but in order to ensure cheapness in the article it must be done by a public authority. Such an apparatus would be properly used as a sink, and some of the lowest of the low might throw ashes in, but the great bulk of the people would use it properly. I have heard of no complaint of misusage of the apparatus in the prison, imperfect as is their supply of water.

What is the expense of main-drains in use for courts at Hull?——About 3*s.* or 3*s.* 6*d.* per yard, 2 feet by 18 inch barrel or arched brick drains.

What would that be per tenement?——In a court or square it would be about 6*l.* for 12 houses, or 10*s.* per tenement. Many of our squares have not 12 houses, and some only houses on one side.

If charged as a rent together with the charge for keeping it in repair, how much would it come to per annum?——Not much above 6*d.* per annum. If there were proper supplies of water, the drains would be kept cleansed, and would require no opening. We find that those drains which are flushed out by the water from the

docks in Hull are kept quite clean. We flush the drains of the gaol and keep them perfectly clean. They are now flushed once a-month. Before that time they were not cleansed more than once, perhaps, in two years. Cases of fever arose which are now unknown.

From experience and positive experiments made at Huddersfield and other places, it appears that if water is kept on at a high pressure the streets may be cleansed with a hose in the same manner as they are cleansed in Philadelphia and other places, where the pavements are made as clean as a ship's deck daily, and the windows and fronts of the houses once a-week; that a mile of street 60 feet wide may be swept by water (from hoses attached to stand-pipes) at an expense of about 7*s.* the mile. If this system were adopted, would it not be of great additional value in giving a flushing to the main-drains and sewers at each time of street cleansing?—Yes, it would have that value, and it would be a great saving at any rate. My only doubts to this question is the smallness of the stones that our streets are paved with, and the *extra expense* of raising water by steam-power.

It is estimated that one sweeper sweeps 1000 square yards per diem. What is the pay of scavengers in Hull?—About 1*s.* 6*d.* a-day, or 9*s.* per week, at this time, when people are out of work; that would give an expense of 2*l.* 12*s.* 6*d.* per mile of street 60 feet wide for cleansing by sweeping.

And that, too, for a mode of cleansing which leaves much surface dirt, that cleansing by water or flushing would remove entirely?—Certainly.

Is the refuse obtained by the surface cleansing of the streets purchased as manure?—I am not aware; the cartage, however, is certainly paid for.

Are the drains in Hull trapped?—I am not aware of more than three street-grates in the town which are trapped, and those I have put in myself.

What proportion of the drains in the town are flushed regularly?—I believe not half of them, but they are not under my control, and I cannot speak positively. Many of our streets have not any main-drains, and others very inefficient ones.

You have the charge of the water-works belonging to the town, have you not?—Yes, I have.

If the piping for the private supplies were comprehended as part of the same general system of distribution, (as in fact they are,) and were provided for to be laid down and kept in repair under one contract, how much cheaper might the work be done than it can now be done separately by private individuals each employing his own plumber?—From 10 to 15 per cent. cheaper certainly.

It has hitherto been the practice of joint-stock companies and others to lay down single iron mains in the streets. What is the practice here; what sized mains are put down for a street say 60

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feet wide?—It varies with the distance from the water-works; those near are of course wider than those at a distance from the works. A six-inch iron main would in general be used for such a street.

Then a single pipe is used for each street?—Yes, at present; in the new works it is intended to have mains.

In a street of 60 feet wide with houses on both sides, there must be 60 feet of lead pipe belonging to the two opposite houses. What would that cost?—I believe it could be laid down, even at present, for about 7*d.* per foot, or 35*s.*; but we have very few streets in Hull of 60 feet wide, and in many streets the cisterns are placed in areas, and in that case 30 feet of piping would not be required for each house.

On medical grounds the use of lead pipes is objectionable; one effect of the infusion of lead in small quantities is constipation, and instances are stated, even from this town, of paralysis, and the colica pictonem, from the use of water where the quantity of lead has become excessive; it appears that the purest water often acts the most powerfully in oxydizing lead?—I believe that when cisterns are kept full there is little danger; but when other matter, such as leaves, get in, and the atmosphere can act to decompose the lead, then there is danger. I had indeed an instance in the case of one of my tenants. It is conceived that some leaves fell into the gutters round the top of the house which collect the rain-water, and decomposed the lead of the gutters. He and his housekeeper drank the rain-water: the housekeeper died rather suddenly; he was dangerously ill, but he escaped with paralysis. R. Craven, surgeon, and Dr. Alderson engaged T. J. Pearsall, an eminent chemist, to analyse the water, who pronounced that the lead was the cause of the disaster.

Are you aware that with some waters lead pipes which are alternately full and empty do not wear so long as pipes that are constantly full?—I have not myself seen that sort of decay. However, I do not see why iron pipes should not be laid from the mains into the houses. If they were provided on a large scale, all bends and proper appliances for carrying water into the houses might be made in iron.

What would be the comparative expense of iron as against lead pipe?—About half the expense if they were made of cast iron.

But even suppose lead-pipes were retained; would it not be an advantageous arrangement to have two main pipes instead of one down each street? What would be the expense of two iron pipes instead of the one mentioned, a six-inch iron main, for a street 60 feet wide?—Two four-inch pipes, which would *perhaps* suffice, would be of the same weight and expense as one six-inch pipe. There would be some additional expense for laying the two pipes down, but that would not be important. There would be the labour and repaving difference, and an additional cost in joints; but I think

they would increase the friction, and require more power at the water-works.

But if the pipes were placed near the kerb-stones, what length of lead pipe might be saved to the private individuals?—About 45 feet for the two houses.

Would not the whole saving be about 30s., or 15s. per house, or 9*d.* of the rate per annum?—I think it might be about that, as some part of the length must be inch pipe at 10*d.* per foot.

Besides this, is there not the saving of the expense of frequently breaking up the streets?—Yes, and that is a very important thing indeed, saving obstructions and inconvenience as well as of money; the streets are never so well in condition after they have been broken up for these purposes.

It appears to be the practice in some parts of this town to have all coal-ashes and dust removed daily, and that this exercises a very beneficial influence on the habits of cleanliness of the districts; do you see any objection to this practice being made general?—None at all of the daily removal; for all small property there are plenty of people who will take it away, and I should think also for the market sweepings, such regulations would be practicable. There might be some objections by the wealthier part of the community at the intrusion.

Have there been many fires in Hull?—Not many; the last large fire happened at a tan-yard.

Was there water wanting then?—Yes, it was. It has been remarked for years that fires have generally happened when the tide was down; and fires might have been got under if the tide-water had been within reach.

Are you aware that at Preston, and other places, where the water is kept on at high pressure, so as to be thrown in a minute over the highest houses, that the loss of time in sending to a distance for a fire-engine, and the chances of the engine being out of order, are avoided, and that the water is brought to bear at once in one or two minutes, instead of in half or three-quarters of an hour?—I was not aware that such was the case in those places; but such an arrangement would be of very great advantage in respect of security.

The extra cost of keeping water on at high pressure night and day (for such a town with no adjacent elevation), either by an elevated reservoir or by keeping a steam-engine constantly at work, is estimated at about one shilling and sixpence per tenement, one with another, per annum. Would not such a charge, less than a farthing a-week, be an economy of insurance, even for a labourer's tenement?—I have no doubt that if such arrangements were made, a considerable proportion of the houses in Hull would have water laid on in every landing in the house. I am inclined to believe that many of them would dispense with insurance altogether, but the corporation would require additional power to charge for

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the extra cost, as they are now limited to one certain price for day only, and that the lowest scale.

Have you seen the cocks such as are in use in Bolton, in which the water only runs when the hand is kept pressed upon it, and stops when the pressure is removed? Might not the proper use of such a cock obviate the water company's objections to keeping on water at high pressure, that there would be much of what is called waste by ignorant and careless people?—We have a cock of this description in use in this town, which was furnished by our engineer, Thomas Wicksteed, Old Ford, which might be more extensively used; but the fact is that the greatest waste we experience is in the present system of having the water occasionally on and generally off; the careless people finding the water does not run, leave the tap open; and when the water does come on, it runs away for hours before they are up, or when they are out. This is a constant source of waste. We are obliged to threaten these people to cut off the water, but the waste continues, and from this very circumstance I believe that keeping the pipes constantly full would be a great saving of water.

Under the suggested arrangements the cost per tenement of the labouring classes would be—

Keeping the water always in the house at high pressure, for domestic use, and for the prevention of fire, and for street cleansing, from	Per Ann. 6s. to 8s.	Weekly. 2d.
The cost of the cleansing apparatus and of house and street drain	2s. 6d.	$\frac{1}{2}$
Total per week.		$2\frac{1}{2}$

against which is to be set the saving of insurance against sickness, the saving of insurance against fire, and domestic convenience and comfort. Would there be any objection to the application of such a system to the old districts, and securing its extension to new ones by general and compulsory measures of economy?—I should think not.

Do you think there would be much difficulty in respect to old houses which are badly ventilated, or houses occupied by the labouring classes, in compelling them to provide ventilation by an aperture opening from a superior part of the room into a smoke flue, or otherwise, to the satisfaction of the surveyor or other properly qualified public officer?—I think the expense would be very trifling if the ventilating flue were carried into a smoke flue, and that might very properly be required to be done for old houses; and a small flue built for the purpose in new cottages.

Have you read the evidence of Mr. Kaye, the builder of Huddersfield, in respect to the provisions of a Building Bill?—Yes, I have.

How far do you concur in it?—Generally I concur in it. There is a variation in the mode of building between that district and ours. They have stone walls, which are stronger than ours

they cannot build their gable walls so thin as ours. I fully concur in what he says as to the advantage of spreading any charge for new works to old or new houses over a length of time, and enabling parties to pay it as a rent. Such charges for the paving or drainage often fall very oppressively in this town. I have heard of instances where it has taken away nearly the whole of the rent. In the case where a house was deeply mortgaged, the mortgagee being clear of all charges, these new charges must clear away the whole of the rent for a considerable time. I have heard of cases of very great hardship of this kind.

You yourself superintend the water-works, and the paving and flagging for the corporation?—Yes, and any drainage that may belong to the corporation.

Are you allowed to take private practice?—Yes, to a limited extent. I am allowed to draw plans and make estimates for private individuals.

Suppose an officer of proper qualifications were required to devote his whole time to the public service, do you, judging from your own experience, see any difficulty in one officer, (after such works as those contemplated for the relief of a town were in action,) as a responsible officer of public works, superintending the general house and street drainage, and road drainage and cleansing, and supplies of water, and seeing to the execution of the provisions of a Building Act in respect to proper drainage, levels and ventilation?—One officer might, I think, do it in general. Here the corporation have a property in houses and farms, producing a rental of upwards of 4000*l.* per annum, and the corporation surveyor could not now do it without assistance. In most towns, with proper assistance, one officer might accomplish the work very well. If the drainage and supplies of water are carried out as parts of one system, they would without doubt be the best carried out under one authority. In laying and taking up water-pipes I should find it of great inconvenience if I had not the control of the pavements. In the Dock Company's ground, where I have no authority over the pavements, it has occasioned delay and obstruction to the public works.

Are you a rate-payer in Hull and Sculcoates?—Yes, I am a rate-payer in Hull and Sculcoates both.

Do you not find payment to a single collector instead of a number most convenient?—I should think the single collection must be highly convenient to the rate-payers.

How many rate and tax collectors are there in Hull?—There are three poor-rate collectors, two water collectors; two collectors for the income tax, one for the assessed taxes, and one for the highway rate.

Mr. Charles
Fox.

MR. CHARLES FOX.

ARE you the collector of rates for the whole of Sculcoates?—
Yes, I am.

What rates do you collect?—The poor's rate, the commissioners' rate, which is the rate for lighting, scavenging, &c.; the highway rate, the borough watch rate, and the church rate.

Are these rates generally collected separately in other districts?
—Generally separately.

Besides these rates, do you collect any taxes?—Yes; the assessed taxes, the land tax, and the property tax.

So that you collect every local or general tax within the district?
—Yes.

Now to the rate payer or to the tax payer does this consolidation afford any, and what practical advantages?—It saves them seven calls instead of one; they would rather be called upon four times instead of eight-and-twenty in the year; they also see at once what the demands are upon them; persons taking premises see at once what are the outgoings. It also affords considerable advantages in the apportionment of those rates which are apportionable between out-going and in-coming tenants; there are fewer disputes and less irritation. The tenant who is in depressed circumstances may be more readily eased by being allowed to make payments by instalments than he could be by a number of collectors.

What are the practical advantages which the consolidation affords to the Government or to the public?—The first decidedly is that there is much less cost of collection; this collection averages between 10,000*l.* and 11,000*l.* per annum, net; the expense of collecting this is about 250*l.*, and securities are given. If it were collected separately, in the ordinary mode, the expense would be double. The expense of the highway rate is 10*l.* for collecting 700*l.* or 800*l.* No man could go round the parish to collect the rate separately for one per cent. I am not in trade. The separate collector must follow some other occupation, and the man in trade is under the temptation to employ the public money as a circulating capital. An instance has recently occurred in the town where the collector of the market tolls engaged in trade has become a defaulter, having, it is presumed, employed the tolls in his trade.

Would not such consolidation afford the advantage of a *pro rata* reduction of the expense of collection on each tax or rate consolidated?—Undoubtedly; and for a much closer collection. The per centage for the collection of the property and assessed taxes is now, however, so low that it will not pay any person of respectability for his whole time. It will scarcely pay labourers' wages. In these districts the collectors of assessed taxes are almost invariably in trade. The consolidated collection is much closer from its being my chief business to call upon the inhabitants, and from its being more convenient to them, and from a better know-

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ledge of the inhabitants and the state of the property than could be got by a number of different collectors, amongst whom there will be changes. It is of importance to the collection of the Government taxes that the collector should be intimately acquainted with the property and be aware of expected changes, so as to be enabled to step in and demand the taxes before any departure. There is also, in the collection of the income-tax, less reserve towards the public officer than there is towards the officer in trade. The deficiencies and discharges for empty houses, &c., of the entire taxes and rates for the parish are, for the three years, about 380%. upon about 34,000%.

How many persons from whom you collect have banking accounts?—About 800, or nearly one-third, as near as I can judge.

Might it not be a practicable arrangement to those who chose to pay their rates and taxes by running order to the banker, to pay all rates and taxes on the demand of the collector within proper limitations, so as to allow the money to pass at once from the banker to the treasurer, or tax-receiver, in the same manner as subscriptions to clubs and charities are now paid?—People who go on excursions to the continent and to watering-places, very frequently leave orders to get the money from the bankers. With arrangements, the system might, no doubt, be extended.

What proportion of your rates would the payments from the 800, or third who have banking accounts, be to the whole amount?—It would be nearly one-half the amount.

FORM of NOTE for Consolidated Collection left with the Ratepayer.

No.	Sept. 1843.	£				£.	s.	d.
			<i>Sculcoates, 20th Sept., 1843.</i>	Poor Rate on £	for Six }			
				Months at 1s. 5d. per £ . . . }				
			Parochial and Parliamentary Taxes due from Mr.	Commissioners' Rate for Six }				
				Months at d. per £ . . . }				
			Messrs. Hayes and Sissons, Church-	Highway Rate for Twelve Months }				
			wardens; Messrs. Garthorne,	at 4d. per £ }				
			Crackles, Lovitt, and Wade, Over-	Borough Watch Rate for Twelve }				
			seers of the Poor; Messrs. Jarvis	months, at 5d. per £ . . . }				
			and Linwood, Surveyors of the	Land Tax for Six Months . . .				
			Highways; and Messrs. Bamford	Property Tax ditto				
			and Fox, Assessors.	Assessed Taxes ditto				
						£		

Mr. THOMAS WROE, Manager of the Gas-Works.

Mr. Thomas
Wroe.

DURING what time have you been in office in Manchester, and connected with the local authorities for the town's improvements?—I shall have been 10 years in March next. I have been secretary to the Paving and Soughing Committee, and the Improvement Committee, besides manager of the gas-works.

Have you read the evidence of Mr. Holme with relation to the sanitary condition of Liverpool?—Yes, I have.

What portions of his observations do you think applicable to

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Manchester?—I think they are pretty generally applicable to Manchester.

Have you read a statement of the principle of raising and distributing over a period of time the expense of new and permanent structural improvements?—Yes, I have.

Do you think the principle sound, and that its application would obviate such difficulties as are stated by Mr. Hopkins as having been experienced in obtaining in Manchester the payment of contribution of new public improvements from the owners or persons in receipt of the rents and profits?—I think the principle of the extension a correct one; but that it should be applied rather to the owners than the occupiers, unless the owners cannot be got at.

In what period, when you sewer a street in Manchester, do you levy the expense back again?—We make the demand at once, and obtain it as soon as we can.

Within what period do you usually accomplish the repayment?—On an average, in about 12 months.

Must not such a mode of levying, and within so short a time, be very severely oppressive?—Very frequently dreadfully so, especially on poor widows and persons who have just sufficient to keep them. It is extremely distressing to see poor widows, who have only a life interest in the property, and without power to mortgage it, come and plead to get time. I would wish further to remark that mechanics who are in building-clubs borrow sums of money which they expend in building; this sum has to be repaid in monthly instalment, with interest; these payments frequently absorb the whole of the rents; and when a demand is made for paving and sewerage expenses, they are unable to meet it, except in very small instalments.

Has the demand for improvements in many cases absorbed the whole rent?—We very frequently find that the expense of paving and soughing, or sewerage, comes to more than the yearly rental.

Is not much of the property, for which persons possessing only a life interest are so charged, property held on lease?—For the shops and large property, that may be so; but the smaller are held from year to year, the smallest from week to week.

Are there houses in Manchester for which you can find no owners?—There are instances both of houses and land for which we can find no owners.

What do you do in this instance?—There are two houses in Gould-street where the owners have not been heard of for the last 20 years. The tenants have paid no rent; and when they wished to remove they have sold their good-will to others, who have succeeded them as tenants. In these cases we have required the party in possession to pay a weekly rent upon a valuation by our surveyor, until our demands against the property were repaid. There was one piece of land in Canal-street for which we could find no owner; and we made a scavengers' yard of it, and charged the

Scavengers' Committee with a rent until the demand on the property was cleared off.

If a power were given to proper local authorities to levy the expense of permanent improvements on occupiers or owners as local circumstances might require, would not that obviate any difficulty in respect to the application of the principle of distribution?—Yes, I think it would.

Manchester is supplied with gas by the public authorities?—Yes, it is.

What is the capital sunk in the gas-works by the town?—198,000*l*.

At what comparative rates are the inhabitants so supplied?—We now supply the inhabitants at from 5*s.* to 6*s.* per 1000 cubic feet. In Liverpool, which is supplied by two joint-stock companies, it is 7*s.*; and in other towns, where the supply is by joint-stock companies, it is usually on the average of 8*s.*

Have you any means of comparing the quality of the gas supplied in Manchester with the quality supplied to other towns?—Mr. Headly, a gas engineer, who is engaged in the erection of gas-works, has examined the qualities of the gas supplied in other towns, and states that the Manchester gas is second only to that produced by the Liverpool new works, which he himself erected. We believe that it is of the first quality that can be made.

Are there any mill-owners or other persons who have discontinued making their own gas?—Yes, several. None of the new mills have erected any new apparatus.

How long has this system of supply been in operation?—The gas-works were established by a contribution from the rates without authority of Parliament in 1817; but an Act giving authority to carry them on was obtained in 1824.

What is the proportion of the loss from leakage of gas in Manchester?—Five per cent.

What has been the net profit to the town from the establishment of these works?—It is 370,000*l*.

Has it been applied to the improvement of the town?—Yes, to the improvement and widening streets of the town.

What extent of the streets have been improved from the funds so obtained?—About 80 streets, squares, roads, lanes, and other places have been improved by these funds.

Do you think the same system applicable to the obtaining supplies of water for the use of towns?—Yes; in some towns the same joint-stock companies that supply gas supply water; and I think that both commodities, light as well as water, might be equally advantageously supplied, as gas is here, for the use of the inhabitants by the proper authorities.

In economy of management, may the management by the town compete in economy with the management by joint-stock companies?—Quite as cheap, even where the same joint-stock company supplies the whole town; but much cheaper where there are two

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companies competing in the same town, where there are two sets of officers and establishments to be paid for.

The chief imputed faults of local public management are carelessness in respect to small savings, redundant and underworked establishments of officers appointed and promoted from party or private favouritism, rather than from any proper qualifications, having no interest in anything but the receipt of their salaries with the least trouble, inaptitude to adopt improvements suggested by the progress of science, jobbing in obtaining supplies; in these respects what advantages are possessed by management by towns' officers as compared with joint-stock companies?—In these respects joint-stock companies have really no advantages over town management; the joint-stock directors, after all, are only tradesmen, who have their own separate business to attend to, and generally they have no scientific knowledge; and joint-stock appointments go as much by favouritism as towns' appointments. A public officer managing such an establishment for a town has always abundance of inspectors. I am persuaded that I should have had a much easier post of it if I had been managing for a joint-stock company.

Have you considered how far the disadvantages incident to either system might be met by any system of contract management?—There might, perhaps, be some system of checks or management applicable to water; but I do not think there could be in respect to gas, for a contractor for gas might make it 10 per cent. worse in quality, and the consumer have no possible means of checking it. I have not, however, considered the subject of contract management.

In a moderate-sized town or district do you think that one superior officer might superintend all the ordinary public works when established, including supplies of water and gas?—Without any difficulty whatever. It would enable a district to give a better salary to a superior officer. They are now often joined by trading companies.

If the town supplied the interior pipes and fittings under one contract, could it not do it much cheaper?—Yes; the private tradesmen often charge high prices. Under one contract or supply it might, perhaps, be done 10 per cent. cheaper.

And would it not be done much better?—Yes; but what is to become of the traders at present engaged in the business? There are, perhaps, 70 master tradesmen in Manchester employed in the supply of gas fittings in the interior of the premises.

That is, 70 masters make profits instead of one, adding thereby to the expenses of the consumer?—Yes, no doubt.

The question was not put with reference to old districts, but to elucidate the principle of the supply in a new district, where no such interests have arisen to be placed in opposition to the principle of obtaining the supply at the cheapest rate; and less with a view to supplies of gas than the question of the applicability of the

principle to the supplies of water to the houses in the poorer districts, where no one has money for immediate outlays, and the capital requisite for taking the water from the mains or pipes being often as great in the aggregate as that required for the outlay usually by the joint-stock companies or the public. Supposing the public to have the means of doing it by one contract, as you suppose, 20 per cent. cheaper than the private individual can do it, will it not be practicable for the public also to relieve the private individual from the difficulty of the first outlay, by spreading the payment over a period equivalent to the duration of the article supplied, and obtaining the return of principal and interest by instalments? Thus, supposing the ordinary wear of interior gas fittings to be 15 years, and the cost of fitting up a shop to be 5*l.*, would it not facilitate the extension of the supply if, instead of asking the yearly occupier to pay down 5*l.* for fittings, which may be worth nothing if he have to leave the next year, the expense were charged and defrayed by an extra rate of 10*s.* per annum, or whatsoever sum might suffice?—No doubt it would facilitate the extension of the consumption.

What is the smallest sized place for which you know that gas has been supplied?—The smallest place of which I have heard is Melrose, in Scotland; that is a small place, with, perhaps, 1000 inhabitants. The capital invested is 800*l.*, and a man acts as manager, stoker, and lamplighter, and in fact does everything at a salary of 26*l.* a-year, and 6 per cent. is paid on the outlay.

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MR. ALDERMAN HOPKINS.

Mr. Alderman
Hopkins.

ARE you chairman of the Paving and Soughing Committee of the town council of Manchester?—Yes, I am.

Will you state the difficulties encountered by the Committee in the prosecution of its labours, and which have obstructed their progress?—The Committee have for some considerable time past had a fund of 10,000*l.* placed at their disposal to enable them to proceed with the sewerage and paving of those streets within the township of Manchester which are not repairable by the public.

By the local Acts of Parliament under which the business of the township is conducted, when one-half of any of the streets is built upon or enclosed, they may be sewered and paved by the Committee; and when completed, the money expended may be recovered from the owners, in order that it may be used in a similar way in other streets coming under the provisions of the Acts.

But practical difficulties have been experienced in recovering the money thus expended, resulting principally from equivocal ownership and poverty. And the Committee soon discovered that the sum of money intrusted to them for sewerage and paving the whole township was sunk in a small number of the streets, and the recovery of it from the owners has been so slow that the Com-

Mr. Alderman
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mittee have been unable to do more work in a-year than say 20 or 30 streets, requiring an outlay of say from 12,000*l.* to 15,000*l.*, although more than 500 streets, but many of them small ones, are in a condition to be proceeded with under the provisions of the Act.

The Committee have felt reluctant to take those prompt means which the law has provided to recover from the owners the money due by them; hence a general delay has arisen in obtaining repayment, and there are many cases where land is uncovered with buildings, and not used for beneficial purposes, and the legal owners are poor; whilst in other cases the buildings are unoccupied; and in numerous cases where they are occupied the owners are so poor that the money is obtainable only by small instalments; and frequently the Committee, in accordance with a provision in one of the local Acts, have to collect the greater part or the whole of the rents from the tenants; these and other circumstances prevent them from obtaining the money they have expended in such time as would enable them to sewer and pave the township within a moderate period.

The general body of the Commissioners of Police, which then had the management of the business of the township, a short time ago, voted an additional sum of 3000*l.* to the Paving, &c. Committee; but the general fund of the Commissioners was, at the time, and is yet, in so low a condition, that the Committee have not been able to make much use of that grant, and their labours in sewerage and paving consequently continue to be materially impeded.

The town council now acting for the township of Manchester, instead of the late Commissioners of Police, have power to allow to owners three years in which to repay the expenses, with interest, of sewerage and paving, but the Committee have not recommended that that power should be used, as it would evidently soon lock up all the funds which the Committee have at their disposal, when their further proceeding would be arrested.

From an early period in the proceedings of the Committee, I have suggested that, to enable them to proceed with greater rapidity, money might be borrowed on security of the local rate (the police rate) for the township; and to avoid pressing with too much severity on the owners, more time might be given to them to repay the expenses, they being charged with interest on the money due; but it did not appear to other parties that there was a necessity for the adoption of such a course.

The principal objections which now present themselves to the adoption of this course are—first, that, according to the present state of the law, not more than 13*d.* in the pound on the assessment of the township can be raised in one year, and the whole or nearly the whole of that sum may be required for lighting, cleansing, &c., the township, so that no adequate security can be offered for money proposed to be borrowed; and secondly, that the provi-

sions of the law relating to paving and soughing are of so vague a character as to make it imprudent to expend a large sum of the rate-payers' money, the recovery of which might depend upon the uncertain result of legal process.

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The former of these objections might be met by power being obtained in a new Act of Parliament, to raise a larger sum than 13*d.* in the pound; but to this it is presumed that the rate-payers would object, unless the application of the additional rate, that might then be raised, were carefully guarded and restricted.

The second objection, relating to the vagueness of the law, and the consequent risk of a large sum of money, might possibly be obviated by a clause providing that no objection to repayment, on account of non-liability, shall be valid unless it be made within one month, or three months, after the street shall be finished.

There can be no doubt that, if in addition to the present paving fund, say 30,000*l.*, were to be placed at the disposal of the Paving Committee, they would be able to proceed with far greater rapidity than they can at present, and to meet pretty fully the requirement of the case; whilst if power existed to give 10 or 20 years' credit, portions being paid annually, the poorer owners might not be more distressed than they are at present in making their payments.

But in the event of such powers being obtained as those alluded to, it would obviously be only prudent, in order to secure the rate-payers from ultimate loss, to give the town council power to recover, after due notice, any money that might remain unpaid, by the sale of the land and buildings in respect of which the owners had been made liable. These remarks are to be taken as coming from me as an individual, without the sanction of the Paving, &c., Committee.

HENRY AUSTIN, Esq., Architect.

Henry Austin,
Esq.

HAVE you had any (and what) occasion to examine the habitations of the labouring classes in the eastern districts of the metropolis? —I have witnessed much of the condition of these habitations; I was resident engineer to the Blackwall Railway, and we cut through some of the poorest property in that district, which is perhaps one of the worst-conditioned districts in London.

How far do the descriptions by Mr. Liddle, the medical officer of the Whitechapel Union, of the tenements coincide with your own observations? —They generally coincide with my own observations. The rooms were small, generally under 100 square feet, varying from 8 by 10 to 10 feet by 12, and generally under 8 feet in height; always occupied by one family. The inmates, houses, and everything in them, horribly filthy; and there was such a complete want of ventilation that it was extremely offensive to go into their rooms on account of the smell. The privies were frequently close upon the back-door, always in a neglected and offensive condition, and frequently running over.

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Esq.

In what condition did you find the subsoil on foundations in the line of the district where the Blackwall Railway was constructed? —It was the state of that soil which first drew my attention to the necessity of abolishing cesspools in towns. I found that the faecal matter, or the soakage from the cesspools, had in some cases actually joined from house to house.

Then the population were living on a vast dung-heap, were they not? —The soil in the immediate connection with the houses and surrounding the foundations was so saturated from the cesspools as to be, in my opinion, in a worse condition than in dung-heaps. It was exceedingly offensive to remove, and it was constantly matter of remark how human beings could be found to do it. When exposed, it drew forth the complaints of the neighbours at some distance. I have no hesitation in expressing my opinion that in all town districts, and in all districts wherever any drainage can be got, the use of cesspools ought entirely to be prohibited.

In what condition were these places in respect to supplies of water? —Some of them had water-butts, but this was not always the case; they were frequently supplied from one cock in the court; the butts were always uncovered, and they must have received the soot and dust and dirt of the neighbourhood.

You are aware that, by arrangements for keeping water constantly in each separate tenement, night and day, the necessity of water-tanks, or of recourse to common stand-cocks or pumps, may be avoided? —Yes; I am aware of that.

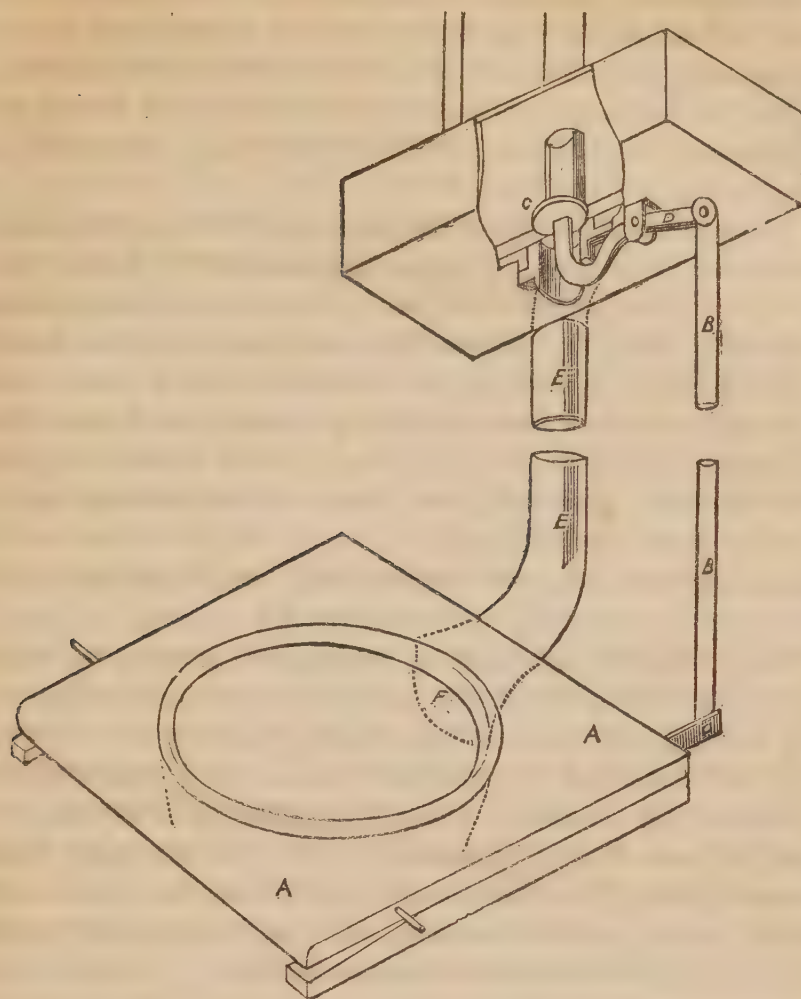
Where such arrangements cannot be made for having water constantly on so as to supersede the necessity of using water-tanks, do you consider that the cleansing apparatus of the nature of the water-closet may be simplified and cheapened? Have you designed an apparatus of this nature? —Yes; the annexed is a drawing of it. I have thought the removal of the cesspool an object of such great sanatory importance that I have turned my attention to this subject. It appears obvious that an apparatus of this nature, adapted to the dwellings of the poor, must be extremely simple, strong, and economical; but, above all, I believe it most important that it should be self-acting: subject to the caprice and neglect of every user, it would be impossible, among the poor, that such places could be kept in a pure and wholesome state. I have designed an apparatus keeping these requisites in view.

At what expense do you consider that it may be constructed? —It may be constructed and fixed complete for 50 shillings, supposing water laid on and the drain constructed.

What do you find to be the expense of emptying or keeping cesspools cleansed? —From 1*l.* to 1*l.* 10*s.* per annum, or from 5*d.* to 7½*d.* weekly.

Do you concur in the practical estimates of Mr. Foden, that all that is required for the drainage and cleansing of houses, sup-

Henry Austin,
sq.



MODE OF ACTION.—The weight of the person sitting upon the seat A forces upward the rod B, which is attached thereto at the back, and causes the valve C at the other end of the lever D to close the lower aperture of the service-box, and to open the upper one, allowing it to fill with water.

On the person rising from the seat the rod falls by reason of its weight, bringing the valve to its original position, when the whole body of water rushes down to the basin. The pipe E is very considerably greater than what is generally used, and is differently connected with the basin, and the fan or distributor F is peculiarly constructed so as not to impede the water, consequently the same quantity acts with very much increased effect, its whole power and velocity being preserved for cleansing the basin and drain, instead of being destroyed and frittered away; thus all the noisome inconveniences arising from neglect are at once obviated, and the closet preserved in a healthy and pure state.

posing that proper supplies of water are obtainable, may be had at an expense of about $2\frac{1}{2}d.$ per week?—Yes; and that an improved apparatus, such as I have described, would not incur an additional rent of a halfpenny per week.

It is stated that, under the old construction of chimneys, where width was required to allow climbing boys to go up and sweep them, seven-eighths of the heat was allowed to escape up the chimney, but that a 5 or 6-inch fire-brick tile tube would now give a better draught and a warmer room. Can you state what economy of construction would, under such a change in this respect, be practicable for this class of tenements?—About 1*l.* per room;

Henry Austin,
Esq.

but the saving in fuel and the additional comfort from a better construction of fire-place and flue would be enormous.

What amount of rent did you find paid for the rooms in the district you have been speaking of?—I cannot say that I am well acquainted with their rents, but 2*s.* 6*d.* per week was an usual rent to pay.

Have you been called upon to advise upon or direct the building of any tenements of the labouring classes, or to study their economies?—I have erected some, but not any large number of such tenements; but the dreadful condition of great numbers of the habitations of the poor, both in the east and west of the metropolis, having been forced upon my notice while otherwise professionally engaged in those districts, I have been led to consider the causes of their wretched state, and to study attentively the economies of this class of buildings.

You are aware that the tenements built for the labouring classes are often most extensively constructed by persons almost of the class of labourers, having little or no capital, borrowing the money sometimes, bartering their labour for materials, having little information to supply extended views and pressing need for the most immediate returns, and to avoid all unnecessary immediate outlay which shall not be demanded by the intelligence of their tenants or customers?—Yes, they are frequently persons who have saved a little money, and have risen from the labouring class. Many of the class of artisans, bricklayers, carpenters, masons, will unite together to build houses on exchange of work. Their want of information is shown by the frequent disadvantageous arrangement of such buildings; much needless expense is incurred in this way. Although wretchedly constructed, with the most pinching economy of material, better tenements might often be erected at less expense.

In respect to the acknowledged necessities and essentials for healthy habitations, a house-drainage, combining the economical means of cleansing, and for that purpose cheap supplies of good water laid on in the house, would it not be equally a peculiar benefit to this class of builders, in respect to these essentials, to relieve them of the necessity of the immediate outlay by its being done under a public authority commuting it into a rate or rent, and an important public security to provide that the work shall be done efficiently as well as economically under the directions of competent officers?—I decidedly agree that it would be of great advantage that the house-drainage and the laying on the supplies of water should be under public control. I do not conceive it can ever be properly done in any other mode. The drains that are supplied in this class of buildings are usually ignorantly constructed, and consequently inefficient, and frequently a source of nuisance and subsequent expense. The supplies of water also are often imperfect, and at all times disproportionately expensive. In erecting some small tenements recently in the eastern part of the metropolis, I had made all arrangements for supplying water

in them at a height of 10 feet. To my great surprise, on its being laid on, it would not serve at a height of seven feet from the street, although the situation was low. Double the expense was incurred, and daily labour is caused to raise it to the required height. Supposing houses for the labouring classes to be built chiefly by the class of builders who now construct them, it would be peculiarly advantageous to charge such expenses as a rate or rent, and it will be the only mode of getting the work done for the labouring classes.

Would you deem it a peculiar aid to this class of builders to have the advantage of a public survey, giving them proper levels, and well-considered, and, as far as may be, pre-appointed lines of drainage?—That is of course; much of the drainage now done by every class of builders, and for every description of houses, is subject to constant mistakes; is found to be at least frequently very inefficient, and has often to be altered at much expense.

Considering always the necessity of strict economy, and avoiding all increase of immediate outlay that is not a means to a reduction of some actual charge, looking to the protection of the class most needing it, as respects new districts exclusively,—what regulations of the nature of building regulations do you deem requisite for new districts?—Much of the existing course of building regulations I think superfluous, and would have a bad effect in new districts. It appears to me impossible to prescribe with safety details to meet every case that will not act in many cases as serious obstructions. All legislative interference beyond what is absolutely required for the health and well-being of the community tends to increased expense of dwellings, entailing among the poor serious evils without proportionate advantages.

To what extent do you deem regulations as to party-walls necessary for tenements inhabited by the labouring classes?—I consider the principle of the prevention of fire is carried too far in prescribing party-walls for this class of buildings, as fires seldom or never occur in such tenements.

For the same classes do you deem regulations as to the thickness of walls, or the materials to be used in buildings, necessary?—Certainly not to prevent houses falling down; for such houses seldom do fall from the weakness of the materials. Regulations as to the thickness of the walls do not ensure good foundations, nor sound materials nor proper bonding of the work, from the failure of which houses most frequently fall. Instances may be given of public edifices and of first-class buildings, from the custom-house downwards, which have fallen, although the walls were sufficiently massive.

How far do you coincide with the following observations of Mr. Hosking, the Professor of Architecture, in respect to the thickness of walls of houses intended for the labouring classes?—

Henry Austin,
Esq.

"With respect to the materials of walls, and the requisite qualities, have you paid attention particularly to that subject, as applicable especially to the humbler classes of dwellings?—I have, and I would beg leave to submit the following remarks upon it: 'Stone and brick are the main constituent materials of walls. Stone walls are considered liable to absorb and give out moisture freely, but any injurious effect from this may be counteracted by battening and lathing and plastering against them on the inside. Some of the more absorbing stones may be plastered on the outside also with advantage; but if this be done, it should be with materials of the best quality, even for the humblest houses, or the mortar will absorb moisture, and do more harm than good. Such plastering should be made with a cement of good quality, or lime of the quality of blue lias lime, and sharp siliceous or quartzose sand. Brick walls ought not to require battening to receive the inside plastering; walls of moderately good bricks, one-and-a-half brick thick, will always do without, but thinner external walls, or such walls built of bricks of very inferior quality, ought to be battened for lath and plaster to be dry on the inside. I say bricks of very inferior quality, because they can hardly be made so soft but they may be made strong enough to bear all that can be required of them in small houses. What we have to do is to render walls made strong enough to bear and resist, of cheap materials, capable of retaining heat and excluding moisture; and lath and plaster upon battens on the inside will do both. Good plastering on the outside of thin brick walls, and proper protection to the walls above, will often suffice to render battens and laths on the inside unnecessary, as these involve greater expense. We have instances of wholesome dwellings where the walls are of tempered clay, with gravel in it; and such walls, properly managed, may, I think, often be made available for cottages where stone and brick are dear. It will sometimes happen that timber is the cheapest available substance that can be obtained for enclosing houses; and timber framed, boarded on the outside, and lathed and plastered on the inside, will include heat and exclude moisture very effectually.

"Do you think battening is required in all cases with stone?—I think in all cases with stone; I know no kind of cheap freestone that would not encourage damp in some degree. By 'cheap,' I mean easily worked.

"Have you any other remarks to make upon that point as to the materials of the walls?—I should say that drains and the footings to walls should be of materials of the best quality. It is generally important that the mortar in which the bricks and stones are set in walls should be of good quality; but if the walls be plastered inside and out, it is of very little importance what the setting mortar is; that is, in low buidings of light weight.

"Have you any observations to make with respect to the substance of the walls of cottages?—I would remark generally, that walls may be safely built as fence-walls to a height of 6 or 8 feet above spreading footings half a brick thick, with narrow piers a brick thick on alternate sides at short intervals, and with hoop-iron bonding laid along at every 2 or 3 feet in height, to stiffen and connect the work. Enclosing walls to cottage yards and gardens may be built much more cheaply than they are built, with a little skill, in that way.

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“Do you apply this to the external walls?—I think walls so built may be made effectual for the party-walls of cottages, but they would be too thin to retain heat and exclude moisture as external walls; though, with piers judiciously disposed to carry the floors and roofs, and aided by hoop-iron bonding, to communicate the strength of the stronger to the weaker parts, what are really not more than half-brick walls may be made strong enough for cottages of 15 or 20 feet in height. Walls one brick thick, with narrow brick-and-a-half piers, at short intervals on alternate sides, may be carried up safely, as the party and external walls of houses, to a height of 25 or 30 feet; and by increasing the piers a half-brick in thickness in the lowermost 10 feet, for every 10 feet of greater height required, a wall nominally, and in many respects substantially, but one brick thick, may be built to the height of 70, 80, or even 100 feet, if the brick be of good quality in the lower parts of the structure. If you call to mind the external walls of some of the most splendid ecclesiastical structures of the Pointed style, you will find that their walls are very thin compared with their height, and with the extent of the buildings. Their power of resisting pressure from within or without is derived from the buttresses on the outside, and the shafted piers projecting from their faces on the inside; and I would carry this practice, for economy of space and materials, into the practice of building generally. Make the wall of substance enough to carry itself, and to prevent fire from communicating from one side to the other, and add to the wall piers or buttresses to enable it to carry any requisite extraneous burden and to withstand any pressure to which it can be exposed laterally. Cottages or other small houses not more than 30 feet high may have their external walls one brick thick, with piers of somewhat greater substance to stiffen them, as prolongations of the party-walls slightly widened, and the party-walls need not be generally thicker.

“Suppose the party-wall is solid, would not it answer for the purpose of a buttress without, having an external projection?—I propose to reduce the general substance of the party-wall, and to give it sufficient strength, by means of piers conveniently disposed, that the including space may not be unnecessarily or inconveniently occupied with walling, which is commonly the case. I contend that both space and materials are wasted in building party-walls throughout of the thickness required at intervals only.

“Do you think that a wall made as you describe for the purpose of economy, which is not to be in some part of it more than half a brick thick, would be thick enough to keep out the variations of temperature in this climate?—Battened, lathed, and plastered upon the inside, it would, I believe, be more effectual than a 9-inch wall without the battening and lathing.

“Then you would not contemplate it without the battening?—I would not contemplate it as an external surface-wall without the battening.

“You think that the battening and plastering would be cheaper than additional thickness?—Under some circumstances it would; in London it would not be so, but there are many places where it would. Lately I made a design for some workmen’s cottages in a part of the country where bricks are very dear; we built the footing-walls of stone-

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rubble, and made the superstructure almost wholly of timber, except as to the party-walls, which are of brickwork, and carried out beyond the external faces, to cut off the communication between the wood-work of the separate tenements. There are places at which it may be cheaper to batten and lath and plaster a thin wall than to make a greater substance of brickwork.

“ You consider that the battened wall in many instances is much more effectual to prevent the external cold coming in than a wall of the same thickness would be if it were all brick?—Certainly, and that justifies the popular opinion that an old wainscotted room is warmer in winter and cooler in summer than a room plastered upon the walls; it is because there is a body of air intervening, and the wood is a less good conductor of heat; and it applies in exactly the same manner, and with better effect, to the battening and lath and plaster.

“ Taking, therefore, a wall of any given width, if the expense was equal by battening a portion of it, you would prefer its being battened—that is to say, if, instead of having a foot and a half thick of brick, you could have it a foot thick of brick and six inches batten, you would consider the battening preferable?—If 14 inches of brickwork would give me strength enough, I would rather have 14 inches of brick and battening inside.

“ If the expense were equal?—If the expense were equal, I should prefer it for the comfort of the dwelling.”

I think the remarks extremely good and valuable; I have no doubt that if better attention were paid to the foundations, and if the building of walls were conducted on a better system, and efficiently bonded, both expense and space might be saved in the construction of this class of houses.

What would be the additional rent entailed by the erection of a party-wall of the thickness usually prescribed for a fourth rate tenement?—I consider that upwards of $1\frac{1}{2}d.$ per week might be saved in the party-wall.

Then do you not consider it safe in the present state of general architectural knowledge to prescribe by Act of Parliament either the sort of materials or the particular modes of working them up?—I believe such legislation to be not only ineffective, but that many decided improvements in buildings is consequently checked. I may instance the increased use of iron and slate that might advantageously take place, improved construction of flues and drains, and the judicious employment of superior cement. I consider that much discretionary power should be vested in proper official authorities in all matters of constructive detail. I have no doubt that many materials, particularly slate and iron, would be used much more generally if it was not for the statutory restrictions.

What is your observation of the effect of the formation of new lines of street, as a means of improving depressed districts, especially in respect to the labouring classes?—It is a frequent argument in favour of opening thoroughfares through densely crowded poor districts, the great blessing they will prove to the neighbour-

hood, in distributing the inhabitants. In my opinion, there cannot be a greater mistake. This crowded population may be displaced, but cannot be removed to a distance; for the nature or situation of the labourer's employment will invariably determine the locality of his habitation; and until, in carrying out such improvements, suitable accommodation is provided for the disturbed inhabitants, the evils of overcrowding in the immediate vicinity must be fearfully aggravated. In the disturbance of the population to make way for the Blackwall Railway, I could not fail to observe that the same poor people continued in the immediate neighbourhood, which before was greatly overcrowded. Although this railway cleared away some of the vilest property in London, I do not hesitate to say that it was an injury to the neighbourhood. I observe that the medical officer speaks of this increased overcrowding as a cause of ill health. It always must be so, unless a proper provision be made for the disturbed inhabitants: the labouring classes cannot go great distances from their work.

Would it have been a hardship upon the Blackwall Company if, as the condition of their being allowed to take down a number of houses occupied by the labouring classes, they had been required at the same time to submit a plan for the reconstruction, and to undertake the reconstruction, of an equal number of improved tenements, for the accommodation of such of the population displaced as might choose to have recourse to them?—So far from its being a hardship, it would, in my opinion, in all improvements, be a general advantage. In the case of the Blackwall Railway particularly, as they were compelled to purchase many plots of ground which they have not known what to do with, and are still lying waste, which would have answered this purpose well. They would have realized a fair interest, and the parties displaced have got a better tenement even at lower rates. I would decidedly recommend such a provision as the condition of improvement bills.

Have you been led to consider that, without any increase of the expense of construction, buildings adapted to the habitation of persons of the labouring classes may be more advantageously arranged?—Yes; I have paid considerable attention to that circumstance, and I would beg to make a few observations thereon. It is obvious that in all suggested improvements in the dwellings of the poorer classes, the ultimate expense to the tenants must be the primary consideration. If sanitary measures are adopted, the operation of which will greatly tend to the increase of rents, they will surely to a great extent fail in their object. Although apart from the consideration of expense, the proper methods that should be pursued will admit of little question, it becomes a matter of the greatest importance to consider how far such measures should be modified to suit the case of the poor. It naturally occurs to every one that wide streets, and large and lofty rooms will ensure a greater degree of ventilation, but it does not follow that increased

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health and comfort to the inhabitants will invariably result. If a wretched, densely-crowded district were cleared away and rebuilt on this system, proper accommodation would be then obtained for only half the former number, and the rents per head would be consequently doubled, and it is clear that the original number must herd together to reduce them to the former level. Thus the evils of overcrowding would be increased by the very means adopted to prevent them. Instead of attempting to disperse the inhabitants over larger spaces, it appears to me that a given area should be made to accommodate as great a number as possible, consistent with the health, comfort, and independence of the tenants, and by judicious arrangements these advantages may certainly be secured without such a sacrifice of space. The poor cannot afford to pay for large areas and large rooms, and therefore the adoption of such must be productive of evil. In populous places, too, the crowding together of great numbers in a small space must be admitted as a necessary evil; any attempt to alter this would appear to be hopeless; but it remains to adopt those structural arrangements and other sanitary measures best calculated to mitigate the inconveniences arising from this unavoidable condition. The first and most important object would appear to be the judicious laying out of property, that the utmost ventilation and other sanitary advantages should be secured without any undue sacrifice of space. This, the very foundation of all structural improvement, is now entirely neglected, left to the ignorance and avarice of the low class of men who usually erect such tenements, whereas, under proper control, and by good arrangements, more accommodation might often be obtained for the tenants at less cost to the landlord. This is a point on which it is impossible to provide with safety, such regulations and restrictions as to disposition and dimensions that will meet every case. It should be left to the control of a competent officer, whose first duty it should be, instead of his time being devoted to matters of comparatively trivial account.

What means would you suggest for ensuring the greatest amount of ventilation, with a due regard to the economical disposition of the houses?—A healthy state of the atmosphere is not at all times secured by wide spaces; it is infinitely better provided by judicious laying out of property than by requiring thoroughfare of certain dimensions; nor will large and lofty rooms avail while the external atmosphere is pent up, and the rooms themselves crowded to excess, and no means provided for carrying off the vitiated air. As no limit can be set to the number of the inhabitants, a large room is productive of evil, and a lofty room without proper means of ventilation will not ensure such a healthy state of the atmosphere as a low room with such provision, while the former, as it greatly adds to the cost of building, tends directly to the increase of rents and to further over-crowding. The erection

of houses back to back, I do not consider would be in the least objectionable, with proper space for yard or other external accommodation for water-closets, dust, &c. To build against three of the four sides of a house should certainly be prohibited. A yard on the side of a house would in all cases be preferable to the back, being ventilated from the street, and readily accessible for the removal of refuse, while back yards of small tenements being completely surrounded, receive no ventilation, and being more out of sight, are generally receptacles for dirt and filth suffered for a length of time to accumulate and decompose. I have endeavoured to illustrate these views by the accompanying plans and sketches. Fig. 1 is a plan of an existing court in Westminster, called "Snow's Rents," a striking example among many worse, of the dreadful condition to which the poorer classes are reduced from the want of proper structural arrangements and control. This court is of considerable width, upwards of 20 feet, but the houses are mostly without yards, and the refuse, when become intolerable inside the houses, is deposited in the court itself, the whole centre being a pool of black stagnant filth, that accumulates from time to time, and is left to decompose and infect the whole neighbourhood. A sketch would convey but a poor idea of the wretched



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character of this place, but I only wish I could accompany it with the faintest notion of the awful stench that is engendered there. Ventilation, or rather a healthy state of the atmosphere is impossible. What little disturbance of the air does take place, would appear only to render its state more intolerable. However much the air may be vitiated inside the houses, this is the state of the fresh air to replace it, and no wonder that the wretched inhabitants should not be anxious in such cases for ventilation. The chief reasons for this dreadful state are the want of yards to the houses, and the width of court being greater than required for the traffic. Had the court been narrower, this accumulation could not have taken place, for the houses would have been inaccessible, and some other provision for the refuse must have been made. Had back yards, however, been adopted, the case would have been nearly as bad, as they would have been quite incapable of ventilation. In juxtaposition with this plan, I have shown a method of laying out the same space of ground by which these

Fig. 1.

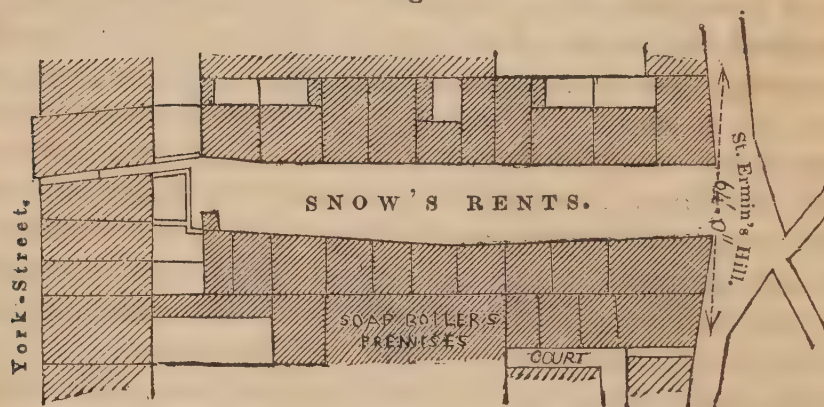


Fig. 2.

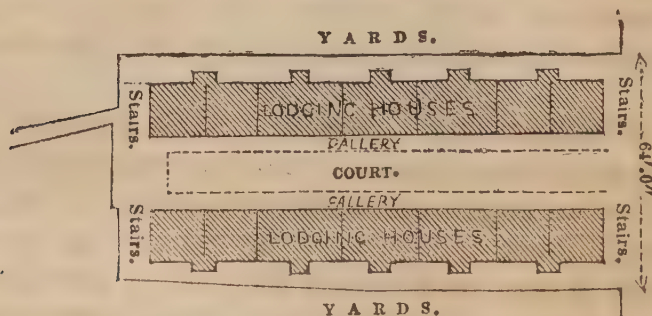
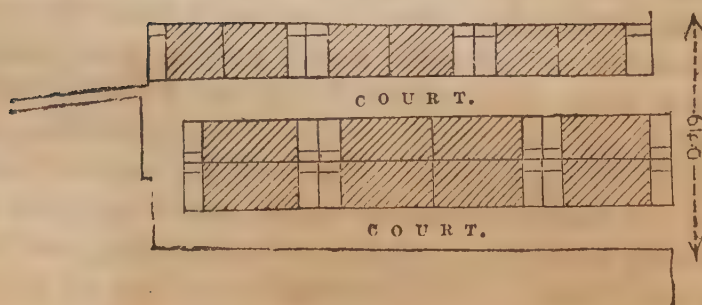


Fig. 3.



difficulties would be overcome, and the whole width of the property, upwards of 60 feet, would be admitted to a free circulation of air, and a small yard with privy and dust-hole provided to each cottage. Comfortable and healthy accommodation would be procured in this arrangement for even a greater number of inhabitants than at present, and this would assuredly invariably result from judicious attention to the disposition of the houses in all such cases. Were this important subject strictly attended to, and other structural arrangements carried out under one good general system, I am prepared to show that property of this description would produce better returns, while the poorer classes would obtain the benefits of ventilation, drainage, and good supplies of water without addition to their rents.

What is the condition of this court with regard to drainage and the supply of water?—There are none whatever there. In wet weather, when the water attains a certain height in the court, it finds its way into an open, black, pestilence-breathing ditch in a neighbouring court; but in the ordinary state of things the whole centre of this place is one mass of wet decomposing filth, that lies undisturbed for weeks, from which, so dreadful is the effluvia at times arising, that in the tenants' own words, "they are often ready to faint, it's so bad!" The supply of water consists in this: that 16 houses are accommodated with one stand pipe in the court! On the principal cleaning day, Sunday, the water is on for about five minutes, and it is on also for three days in the week for one half hour, and so great is the rush to obtain a modicum before it is turned off, that perpetual quarrelling and disturbance is the result, and water-day is but another name for dissension.

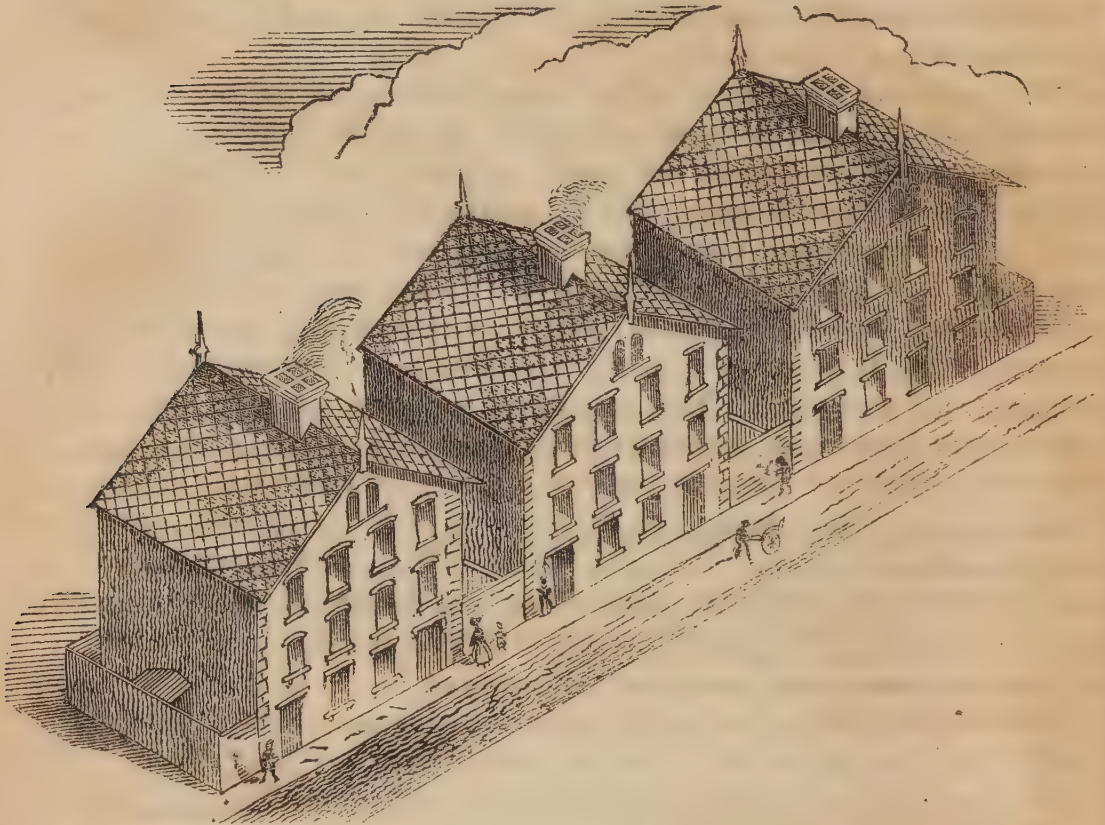
Is the court well supplied with privies?—No; there is one exposed privy at the end of the court for the use of the inhabitants, male and female, of nine houses, which has not been emptied for four years or more, and in seasons of wet is actually overflowing with soil.

Have you formed any estimate of the expense and probable return which might be obtained from the erection of houses on the same ground of an improved construction?—The accompanying plans exhibit different methods of laying out the space of ground, called Snow's Rents, with a view to perfect ventilation, either as private lodging-houses, adapted for letting each floor separately, or as private dwellings. My object in producing these plans is to substantiate the opinion above expressed, not only as to the incalculable benefits that would result to the poor and industrious classes from their habitations being constructed under a proper system and judicious regulations, by a superior class of capitalists, but also as to the opportunity it affords for an excellent investment of capital. I have estimated these buildings on a liberal scale, and the result more than confirms that opinion, as the following summary will show. The estimate for a row of buildings, as in fig. 3, including yard, perfect drainage, self-acting water-closet,

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dust-bin, water laid on to each floor, and annual supply, ground-rent, and insurance, amounts to 4500*l*. There are 78 rooms, the average size 132 square feet, being larger than the existing rooms, and according to the present rate, would accommodate about 200 inhabitants. The average rental now paid in this vile place, 2*s*. 4½*d*. per week per room, about 11¼*d*. per head, would return upwards of 10 per cent. upon the outlay necessary for substantially building the whole, with every structural arrangement requisite to render them healthy and comfortable dwellings.*

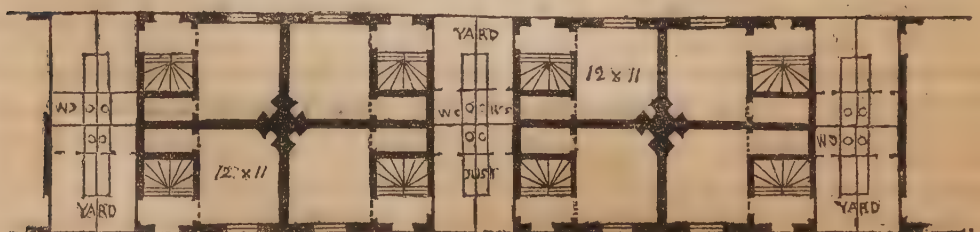
Proposed "Back to Back" Houses as in Fig. 3.



Plan of proposed "Back to Back" Houses as in Fig. 3.



COURT.

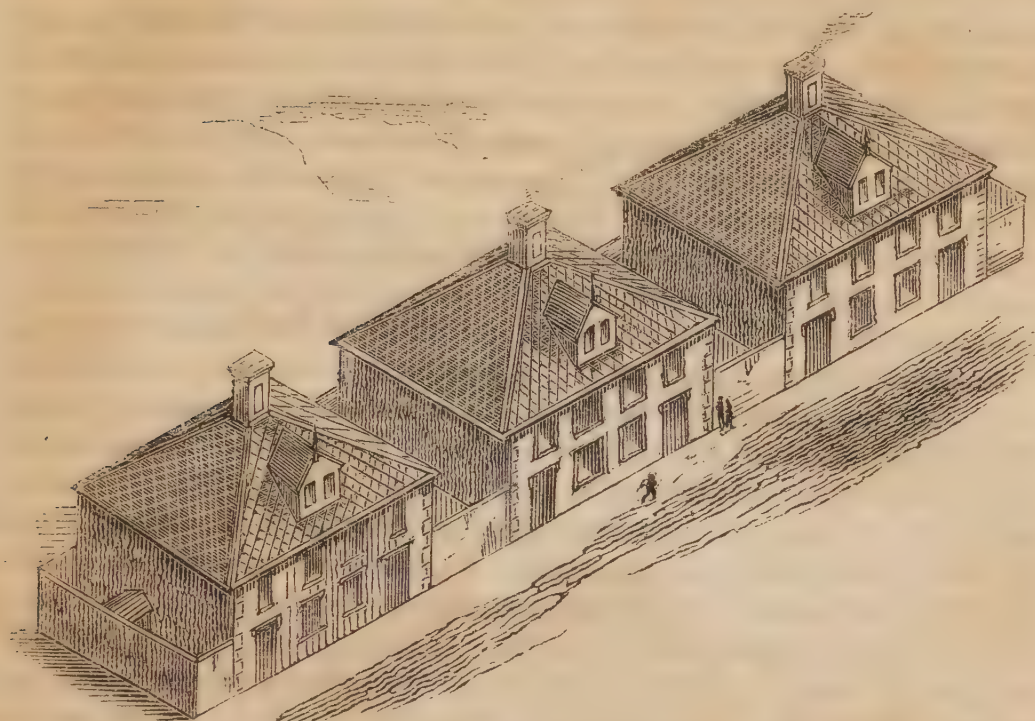


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* See Note on Page 361.

Proposed "Back to Back" Houses for Open Districts.

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NOTE.—The following statement has been furnished by Mr. Austin, converting the charge for water, ground rents, and insurance into an annual expense:—

	£.	s.	d.
The erection of the 18 houses complete, as in Fig. 3, will amount to	2,267	0	0
The paving and divisions of yards, the erection of water-closets, self-acting apparatus, dust-bins, main drain in court and drains from houses, cisterns, water-pipes for supply in every room, sinks, cocks, &c., complete . . .	620	0	0
Contingencies—say	113	0	0
	<u>£3,000</u>	<u>0</u>	<u>0</u>

The 18 houses contain 78 rooms.

The average cost will be 166*l.* 13*s.* per house, and 38*l.* 10*s.* per room.

An average rental of 2 <i>s.</i> 4½ <i>d.</i> per week per room will return	481	13	0
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The annual expenditure in repairs, collection of rents, water-rates and taxes, ground rent, and insurance, will amount to	160	11	0
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Remaining per annum	£ 321	2	0
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Being upwards of 10 per cent. upon the outlay.

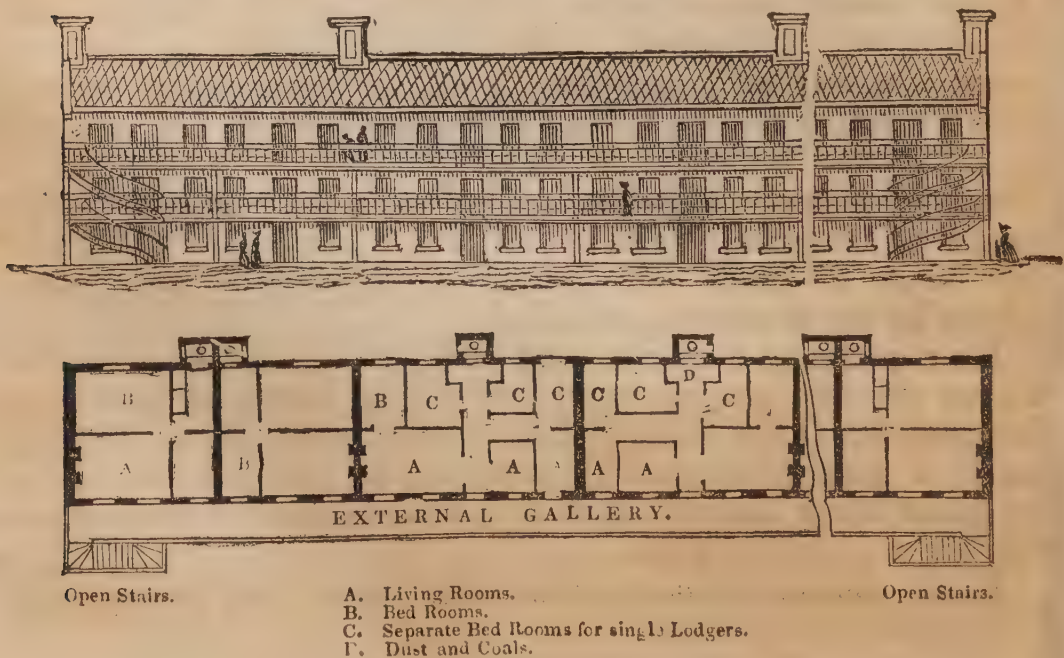
Such buildings should be entirely free from all kind of ornament tending to increase the expense of erection in any degree that would occasion the least additional tax upon the tenants, but that the dwellings of the poorer classes should at all times present as cheerful and neat an appearance as possible, is a matter of more importance than would be generally imagined, as tending, without doubt, to a corresponding effect upon the inhabitants themselves. With a proper exercise of judgment and taste, however, much may be frequently accomplished towards this end, and somewhat of an architectural character obtained at the same time with little or no additional expense.

The diamond slating, shown in the accompanying sketches, produces a very ornamental effect in execution; it is more economical than the ordinary slating, and possesses other important advantages.

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It has always appeared to me that many great advantages would result to the poor, if the erection of their dwellings could be undertaken by a better class of men than those who usually construct them. It is an object well worthy the attention of capitalists, the erection of suitable houses for the accommodation of the poorer classes; for, while improving their condition, a good interest for capital would be ensured. Several attempts of the kind to ameliorate the condition of the humbler classes have at various times been made, and it may excite wonder that they should not have succeeded, but the reason of their failure appears to me to be simply this, that the independence of the tenants has not been preserved. These institutions have been planned in their structural arrangements, on the basis of hospitals and similar establishments, entirely of a charitable and dependent nature. The privies, wash-houses, water, and other necessities have been in common, and the inmates, being thus constantly thrown together, continual disturbance has been the invariable consequence, and hence the necessity of a control being exercised, which those possessing the means of providing other accommodation, and so far being independent, will not brook: such institutions, to be successful, must be removed in their character, as far as practicable, from any appearance of charity or dependence. The object should be to render the tenant's position an independent and responsible one. One man's habits or interest should interfere as little as possible with his neighbour's. All things necessary for his comfort being provided, he should be made to feel that the possession of it depends entirely on his own good conduct. With such inducements for improvement, he will soon discover that he has a responsible part to act, and become a better character. I am convinced that it is only by placing the inmates entirely on an independent footing that such institutions can permanently succeed.

Lodging Houses, Elevation and Plan of as in Fig. 2.



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In the accompanying plan I have endeavoured to embody the chief requisites for such an institution, but in a single sketch this can only be very imperfectly accomplished. The building should be so arranged as to accommodate the greatest number that it conveniently may, but with as perfect a separation as can be required. All the rooms should be small; it is surely better that different branches of a family should sleep separately in small rooms than in one large one, or that one man should occupy a room little larger than a closet, provided ventilation is secured, than share with others a much larger space. Every separate set of apartments should be provided with a water-closet, perfectly ventilated, and should have dust-bins, sink, and coal-closet. The apartments should be arranged in different numbers to suit the requirements of different families, to avoid under-letting. The rooms let out as separate sleeping-rooms should each be provided with water and basin, and have access to a water-closet. Nothing should be in common throughout the building, except the passages and staircases, and these should invariably be external in front of the building, and treated entirely as the public footways. The passages should be in the form of galleries, constructed of open iron-work, that the light may be unobstructed, and that greater cleanliness may be preserved. Staircases of the same material should be provided at each end, that every portion of the building may be equally accessible. The external character of such buildings should be neat, but as plain as possible, and, above all, devoid of all appearance of public establishments.

EXTRACT of a LETTER from Mr. W. DYCE GUTHRIE, relating to the application of CLAY PIPES for HOUSE-DRAINS and SEWERS in the TOWN of AYR.

W. Dyce Guthrie,
Esq.

AFTER much consideration of the best system for the construction of main sewers, I have at last arrived at such conclusions as neither I nor any of those scientific friends whom I have consulted on the subject are able to detect any mistakes in. The first leading principle which I am desirous shall be distinctly understood is this, viz.: That there is no other proper means of removing the débris of houses, towns, and cities, whether large or small, but through the agency of water, which cannot be too abundantly supplied.

How properly to direct and duly to economize water furnished for this purpose, must hence be a matter of paramount importance. That none shall be wasted carelessly, and that as small a quantity may on all occasions be rendered as efficient as possible are matters of the greatest moment. These therefore are my cardinal points.

It now became to me manifest that from these premises the

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grand object would be, so to proportion drains that their supply of water would at all times be effectual in removing soil and preventing depositions of all kinds.

This, it is clear, could only be done by causing them to bear a proper ratio to the roofage, and the size of tubes through which water is conveyed to the house from which the drain is to be led. Now if, as is almost always the case, the water-pipe of an establishment leading from the main be only half an inch, or say an inch, it struck me that there could be no necessity for a construction of one foot, one and a half feet, two, and even three feet calibre to conduct this water with its accompaniments from the house into the common channel or main street sewer, it having merely acquired the addition of the soil. For example, if I furnish a house with water by means of a half-inch water-pipe, it is clear, the most that a drain could ever be called upon to accomplish would be to afford a conduit to the main sewer, but if water can flow through a half-inch tube, it assuredly can meet with no obstacle or hinderance to its progress in a two or a three-inch tube, care being taken that sufficient strength be given to the drain tube.

The rule for the size of the drain-tube is therefore simple, viz., to the calibre necessary to carry off the water laid on add that required for the reception of the rain or surface water. This is readily calculated from the indications of the rain gauges of the locality. I conceive that the grand point in the arrangements is never to have the capacity of the sewer so vast that the advantages of the force of the water which it is intended it should transmit shall be lost, which of course must necessarily be the case if such disproportions occur as that which I have already mentioned. The next point I had to establish was the nature of the materials best calculated for the construction of conduits for sewage, as it was apparent no brick building or mason work (if my data be correct, of which I have now no doubt) could at all be made available for sizes so small as that which I contemplated introducing. I therefore consulted with the manufacturer of tubes of terra cotta and different other kinds of clay as to their expense, and the probable strength which might be given to tubes of from two to eighteen inches diameter, and the result was in all respects so satisfactory, that I soon came to the conclusion that no house-drains or private sewers could, by possibility, be perfect in their operations if built either of brick or stone, and that the substitution of strong tubes of small calibre made of indestructable materials would be found an invaluable improvement. As the strength of the tubes which I propose using as conduits for sewage has frequently been questioned, I beg to submit the following fact, which proves indisputably that objections to my system, founded on this basis, are perfectly untenable. A few specimens of fire-clay tubes were manufactured in the neighbourhood of

Glasgow by the Gaonkirton Coal Company, and these were, in the presence of a number of scientific and interested gentlemen, tested by hydraulic pressure, when it appeared that it was not until a greater pressure than that equal to a perpendicular column of water of 900 feet had been applied that they could be burst! I was not present when the experiment was made, but Mr. Smith of Deanston, and several distinguished persons who were, informed me of the fact. But a moment's consideration will serve to convince any one that a conduit for any fluid must be stronger if formed in complete circles than if made up of numerous small fragments which have no affinity for each other; in fact, which only preserve a form or shape, by the sheer force of their surrounding and superincumbent pressure. Two years have elapsed since I first mooted this idea, and I have much satisfaction in now being able to state that the principle was at once conceded by scientific persons while I was in London; and that since my return to Scotland there has not been a single sewer built either of stone or brick in the town of Ayr—clay tubes have invariably superseded them. The Ayr arrangements, however, I am sorry I cannot altogether approve of, because no principle seems to have been recognized; all that appears to have been thought necessary, was the adoption of circular clay tubes, instead of the old expensive rude brick or rubble-built drains. Notwithstanding this, the people are unanimous as to the great advantage which the tubes possess over the old system. The sizes employed are from nine to eighteen inches, dimensions, which, for reasons here stated, and which also appear in the body of my evidence, I entirely disapprove of for the purposes of mere house-drainage. The tubes should be made of fire-clay and glazed; the glazing does not add sensibly to the cost, and would be a great improvement. It may be interesting here to remark that I was particularly struck during my stay in Ayr by observing the loss which a community sustains from the want of combined action.

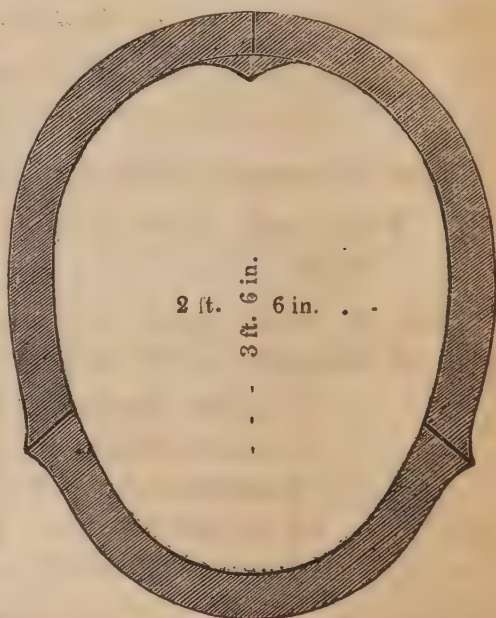
W. Dyce Guthrie,
Esq.

If public companies, curators of local trusts, and private persons were to digest properly their schemes, and cordially to co-operate, it is easily demonstrable that much economy, in every sense of the term, would invariably be experienced. In the town of Ayr, they have no Act empowering the authorities to cause inhabitants to adopt such arrangements as have recently been shown to be indispensable for the protection and preservation of public health; therefore every man who desires to improve his premises, entertains that desire from a conviction of the necessity for making certain alterations, in order that the health and comfort of his family may be secured. But as there have, in this place, been no public meetings to discuss the merits of those suggestions which have been offered for the general improvement of the town, every one must proceed as his own architect or builder may choose to dictate, irrespective of his next door neighbour's

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Esq.

operations. Each who desires to lead his soil-drain into the main must make his own direct communication with the main. I have endeavoured to point out the folly of such proceedings, by showing to the parties the vast saving which would be effected if neighbours would only consult each other, and harmoniously co-operate.

I showed, to the satisfaction of competent persons in Ayr, that if proprietors in the lower and descending parts of streets would allow the landlords on the higher grounds to make connections with the private drains of those as they descended, each bearing his own expenses, or such proportion as might be required to convey the tube past his property, that then one connection only with the main would be necessary for a number; the expense of making which, if divided amongst a number, would be comparatively trifling. This system which I propose, I have no doubt will, ere long, be universal, as its advantages are obvious. Having sufficiently and satisfactorily established the principle that all drains or sewers ought to bear positive reference to the quantity of water, &c., which it can be calculated they would be required to convey, and having ascertained that in the case of small or house-drains, this was matter of easy accomplishment, I next directed my attention to the common or main receiving sewers, and with a view to show that the same principle which prevails in the small will also be found to regulate the large, I consulted scientific and practical men as to the possibility of constructing sewers in two, or three, or four pieces, instead of the common tedious, imperfect, and expensive mode of brick-building in cement or mortar. I proposed the adoption of pieces of fire-clay moulded in the most unobjectionable forms, and of great strength, which requisite, I was assured by the manufacturers, thickness and high temperature would, in the case of this material being employed, be certain to secure. The fixing upon the best configuration, now started up as a new difficulty; at last, however, I succeeded in convincing myself and such scientific friends as took interest in my pursuits, that the section of the form represented in the accompanying sketch is decidedly more perfect than anything that has hitherto been employed for sewerage purposes. It has also been asked what pressure externally and internally would such a construction as this withstand, the answer is simple,—No superincumbent weight whatever could crush it (this the manufacturers,



one and all, guarantee); the pressure which it would bear from within would be in the direct ratio of that from without; a glance at the diagram will show, that, like a brick-built circle, it has no strength save that which it derives from the pressure of the surrounding materials. The cost of a sewer of the dimensions marked on the diagram, would be about 18*s.* or 1*l.* per yard. I find that fire-clay tubes, 12 inches diameter, and 12 inches in length, can be purchased in Glasgow for 9*d.* per foot, or 2*s.* 3*d.* per yard, which is exactly *half* the prices furnished to me by the London manufacturers. The manner in which small or side drains are connected with this kind of sewer is simple; circular openings of various diameters are left at the time they are made in a great proportion of the side pieces, a little above that part where they rest on the invert, into which a tube of from three to twelve inches may be inserted as the case might be.

W. Dyce Guthrie,
Esq.

The following is a calculation which I made while in London in April 17th, 1843, with a view to show the economy which would be effected by the adoption of small strong tubes instead of brick-built sewers:—

Brick-built, First class	. 2 <i>l.</i> 10 <i>s.</i> per yard	4,400 <i>l.</i> per mile.
, , Medium class	. 1 <i>l.</i> 10 <i>s.</i> per yard	= 2,640 <i>l.</i> per mile.

These are the prices of the Holborn and Finsbury metropolitan district of sewers, furnished to me by my friend Mr. Roe, civil engineer.

Tubes of terra cotta or fire-clay:—

Tubes of 1 foot 6 inches diameter, at 15*s.* per yard
= 1,320*l.* per mile.

Tubes of common brick clay:—

Very best, 1 foot diameter, at 3*s.* per yard = 246*l.* per mile.

Prices of drain tubes, in Glasgow, of common clay, including flanch of from one to two inches:—

3 inches diameter,	6 <i>d.</i> per yard.
6 inches diameter,	9 <i>d.</i> per yard.
9 inches diameter,	1 <i>s.</i> per yard.
12 inches diameter,	1 <i>s.</i> 3 <i>d.</i> per yard.
18 inches diameter,	2 <i>s.</i> per yard.

Tubes of cast iron, of 12 inches diameter, would weigh about 2¼ cwt. per yard, the cost of which would be 6*s.* 6*d.* per cwt., or say 14*s.* 6*d.* per yard, of a strength equal to 300 feet pressure, which would be = 1,276*l.* per mile.

These prices it is to be understood are merely approximations, as the manufacturers were especially requested by me not to furnish me with quotations less than the present wholesale prices of the

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Esq.

articles; so of course if a great demand were to take place for extensive sewerage operations, there can be no doubt the materials could be had for little more than half the prices I have mentioned, more especially when it is known that the tubes can be manufactured with great rapidity, by machines, driven either by steam or horse power. I have myself a working model for this purpose, which I invented three years ago, and which operates beautifully.

Earthenware pipes from the Shropshire Pottery may be obtained through Messrs. Darby and Co., Coal Brook Dale, Shropshire.

Fire-clay pipes, 4 inches diameter, 1s. per yard, and 6 inches diameter, 1s. 6d. per yard, from the Garnkirk Fire Brick Works, Glasgow.

There are a great many niceties to be attended to in the reducing this system to practice, so that its perfection may be completely brought out, and its efficiency of operation secured. The manner, for example, of connecting small tubes with each other, and these again with the great receiving or common sewer. The mode of keeping sewers free from deposit by flushing I have sufficiently explained in my evidence. I may, however, remark that if the tubular *system of sewerage* were to be properly conducted, that no such flushing apparatus as that described by me, or any other contrivance for this purpose, would ever be required; and I am convinced that in a few years brick-built sewers will be but the *rare exceptions*: whole towns and cities will be sewerage at small cost, and more perfectly than it is possible to accomplish by brick building. I purpose as speedily as possible publishing a small treatise on sewerage, in which I mean to show the objections which pertain to those colossal constructions that exist, and continue to be made in the metropolis; the means best calculated to remedy their defects, and lastly, describe the kind of sewerage which I think unobjectionable, and what I would therefore recommend for adoption in all cases where new sewers are required.

In the mean time I shall only add, that it will afford me great pleasure to communicate with such parties as may desire to be informed on this interesting and important subject, and to furnish them with every information they may require, or that I am possessed of.

I am, &c.

V.

ON THE CLEANSING OF HOUSES, THE REMOVAL OF REFUSE
FROM STREETS, AND ITS PROFITABLE APPLICATION.

MR. WILLIAM THORN, of the firm of Stapleton and Thorn,
examined.

Mr. William
Thorn,

ARE you a contractor for cleansing any part of the metropolis?
—Yes.

As well as a wharfinger?—Yes.

For what portion of the metropolis do you contract?—The south-western division of St. Pancras, the Foundling Estate, the Doughty Estate, the Pancras Union; and the St. Mary's division of Marylebone for dust only; all the rest are for cleansing and dust.

Is the dust let separately from the rest?—It is in some parishes.

Does this district, for which you contract, lie all compact, or is it subdivided?—It is not within a ring fence, but it is not a very great way apart.

Are there other contractors coming in between?—There are.

Does that add to the expense of cleansing the parts for which you contract?—I should say, most decidedly.

The distance you have to go and the expense of supervision over your men is greater?—Yes, it is that which increases the expense.

Do you experience difficulties in properly cleansing those districts?—It would not be for me to say that we do not, but we have very little trouble; and I believe there are none of the surveyors under whom we have worked that can say much against us.

Have you difficulties in disposing of the stuff that you collect?—I am sorry to say that we have.

What is the cause of the difficulty?—That point would be beyond my power to say, it would require a political economist; the state of prices is such that we should lose money if we disposed of the article; we are obliged to hold it back for that very reason.

Do you find a difficulty in finding lay-stalls where you can deposit it?—At present we have not any great difficulty, having beneficial leases of some for long terms.

Is not there an increasing difficulty in finding places where filth may be deposited in the vicinity of the populous parts of London?

—I should say that it was the general feeling of the inhabitants of London not to have a lay-stall nearer to them than can possibly be avoided.

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Thorn.

Is not there a rapid increase of buildings in the vicinity of London gradually covering over those places that were formerly used for such purposes?—Yes; they drive us out.

And the inhabitants make an objection to your coming there?—Yes; they say they do not like our men, and they do not like our carts; we are not very pleasant sort of people.

By increasing the distance you have to go, the cost of taking it is increased?—Certainly, our profit is very much diminished.

What is the greatest distance you are obliged to cart?—We have one place in Maiden-lane, close to the Canal-bridge, which I suppose is a mile from one part of Tottenham-Court-road. We have that place on a beneficial lease of sixty-one years to come. We have laid out 1,800*l.* in building on the premises for the purpose of getting a beneficial lease, and so far we are safe for that number of years.

Is the filth and dirt that you carry there taken away by canal boats?—No; the canal duties are too high.

Then you have no advantage in its being close on the banks of the canal?—Except for the ashes and breeze; we keep the canal-boats continually moving for those.

The ashes and breeze being used in the manufacture of bricks?—Yes.

For what purpose is the remainder of the stuff used?—If we mix the street sweepings with horse-dung and cow-dung, we get rid of it to the farmers, who use it for fallow lands for manuring, for turnips and wheat, and all their produce, in fact. If we sell it alone without mixing it with horse and cow-dung, it is put upon meadow-land after the first crop of hay is off.

Is that the night-soil?—No.

Do you also carry night-soil?—Not to our wharf.

Have you difficulty in finding places to lay it?—We have one place to which we can carry it, over the Canal-bridge, about 500 yards on the same road. We lay it there in the midst of a very large field; the person who allows us the privilege of shooting in there (Mr. Clarke), bakes it, I believe, and sends it over to the West Indies.

In what district is the place where it is baked?—It is on the other side of the Canal-bridge, about 500 yards, very near to Bell's Isle.

What is the average cost of cleansing out a cesspool?—It is done by the load. Our average is generally 10*s.* a one-horse and 15*s.* a two-horse load.

Is the load about a cubic yard?—As near a cubic yard as possible.

How many loads will it take upon the average, taking a fourth-rate house, with two families?—The houses we are most in the habit of removing night-soil from are lodging-houses, with a family on every floor. That is about five loads.

How often in the year do you cleanse those?—Once in a year, or once in eighteen months. It is impossible to state it exactly, because they do not employ the same person twice, if they can get it done a shilling or two cheaper by another.

Each individual makes his agreement with you; and he makes his agreement with you because you happen to be the contractor for the dust and refuse?—Not exactly that, but because we happen to be the lowest in price.

But in many instances, where you happen to be the contractor for the dust and refuse, they agree with you for the cleansing of the privies?—It depends more upon our connection with the builders.

Would the amount for cleansing the cesspool of a fourth-rate tenement, with two families, be rather under than over 1*l*.?—It might be done for about 25*s*., I should say.

Your contracts are to cleanse the streets, squares, alleys, and courts?—Yes.

How often?—Almost every parish differs. I should say the worst places once a-week: places in which a cart cannot enter.

What district do you apply that to?—Those parishes that we are now working for. We have very few courts in them; but in the parish of St. Giles's, that we held till the 24th of last month, there were a great many of those places. In what was called the Rookery in St. Giles's, we were always compelled to go twice a-week.

Was there a great accumulation of filth in those places?—They are the most filthy that I know.

In that part there are no regular ash-bins or places to put ashes in?—No; it is thrown into the street, or anywhere.

In consequence of the refuse dust and ashes being so thrown, are they not frequently carried by the water, when there came a flood of rain, into the drains and sewers?—It would seem exceedingly probable.

Are there any sewers in the district?—There are common sewers; but there are no drains from the houses.

Are there regular privies in those houses, or cesspools?—I do not think it is universal at all. During the last thirteen weeks of the St. Giles's contract we were paid 5*s*. a-week for keeping the inhabitants in Lascelles-court, Holborn, decent; preventing them making use of a small place which had seemed to have been originally an old watch-box, and a place of filth it was. We used to send a barrow in at four o'clock in the morning, and take it away.

So that they had no convenience at all?—No. At that time they threw the dust into the night-soil, and rendered it worthless. We were paying a large sum for the dust, and it was a great loss to us.

Do you find a market for your dust with the brick-makers?—We generally do.

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Thorn.

What proportion does the dust bear to the breeze?—I should say there is about two parts of dust to one of breeze. There is hardly one of breeze.

Does not the want of any convenience in the way of ash-holes, or a proper place for dust, for those poor tenements in the district you speak of, give you a great deal more trouble than you would have if such places were provided?—There ought to be in every court a public dust-bin, and the inhabitants ought to be compelled to put their dust into it; for when ashes and breeze have fetched the high price we have given for them, and they throw our dust into the street, and mix it up with night-soil, we lose a great deal of money in the course of the year. We are paid for the cleansing, and pay for the dust: the difference we receive from, or pay to the parish.

Then this carelessness and waste, which arises from the want of having some ash-holes provided for these poor districts, is a source of expense to the parish, and of loss to the contractor?—It is a loss to the contractor, and it is also a loss to the parish; because if a proper dust-bin was provided we should not have to go into the Rookery above once a-week; whereas the parish officers said it would breed infection, and we were obliged to go twice, and the parish must pay for it.

Do you think that the having small bins, and having more of them, would be better than one large bin?—We should be robbed, as contractors, if there were portable bins; for in those neighbourhoods they would sell the dust as they pleased.

Do you think the bin might be contrived in such a way that the ashes should be emptied into the top through a thing like a hopper, and should be locked in, so that they should not be able to get them out?—It would be a great advantage to the dust contractor, and also to the parish.

It would lessen the expense, and it would prevent fraud?—Certainly.

Besides the refuse of dust, have you not a great variety of miscellaneous refuse frequently mixed up with the dust which you get in the houses, such as bones and other things that are thrown away?—Yes; cabbage-leaves and pea-shells. The bricklayers will not buy breeze at this season in consequence.

How do you dispose of the bones and those things?—Our general plan is to contract: we underlet our work of sifting to a man, and we give him everything that it produces except the ashes and breeze. He gets the rags, and bones, and other things. The oyster-shells belong to us: he sells the bones.

What sort of person is he: is he a labouring man, or a man of any capital?—He must be a man that has 30*l.* to begin with at all events.

He employs men under him?—He employs men, women and boys under him.

Does the separation and use of that refuse become a mercantile consideration?—It does.

Are there cases where the proprietors have large transactions with the sal-ammoniac manufacturers and others?—We have nothing to do with it; but I should say not. I am not aware that we deal in any article that will make sal-ammoniac. The bones are almost always sold to the Jews; and they send them away in barges, and they are taken and boiled, I believe, in the country somewhere, and ground and used as bone-dust for manure.

What is done with the rags?—The fine rags are washed; and if they can be made anything of, they are taken and disposed of to the paper-mills, for the purpose of manufacturing paper. The woollen coarse rags are taken into the country, and laid down till they moulder away, and then the rag-dust is sold to the hop-farmers in Kent. It is a most excellent thing to prevent the fly in the vine. Oyster-shells, broken crockeryware, and everything that we call "hard core," is sold to the contractors for roads. If we do not happen to be making a road ourselves, we sell it to any road-contractor, and he makes the bottom of the road with it. There is no better thing in existence.

Do you remove any dead animal matter that may be cast out: in the sweepings of the streets would you consider yourself responsible for removing a dead dog?—If the vestry or the surveyor were to say to me, "You shall remove it," I should not consider that I was bound to do it. I do not consider that they have a right to throw it out.

You do not make any commerce of that sort of animal remains?—No.

Are the bones disposed of in general soon after they are received?—Our men are men of very small capital. They are obliged to dispose of them every week, at all events.

Do you pay your men by task-work?—No: by day-work.

What do you pay a-day?—Our lowest price, when we have been obliged to employ a great many men, has been 2s.; but we never paid that except upon our contract in St. Giles's. But our lowest price now is half-a-crown.

What quantity do you deem a fair day's work? Did you ever reckon the number of square yards that one man with another should sweep in a day?—No; we do not go so particularly into it as to take it by the square yard. We say that a horse and so many men should sweep so many loads in a day.

Did you ever make any estimate as to what quantity you can sweep with a given number of men, or what quantity of labour a street will require for proper cleansing?—No. In the neighbourhood of our wharf at Battle-bridge, for the Foundling estate and the Doughty estate, together; we have had three sweepers and a horse and cart in dry weather, but in wet weather we have an

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extra cart and an extra man. Those three men are bound to cleanse the estates twice a-week.

How many loads in a day?—I do not consider that the horse has done his day's work unless he brings in four load, at all events in dry weather.

What would they do in wet weather?—In wet weather we make the horse do an extra load.

That is five loads?—Yes; that is from a district, the furthest point of which would be half a mile from our wharf.

Have you any sort of estimate as to what quantity of dust 50 or 100 houses will afford?—No; but I can give the number of chaldrons of almost every parish at the west end of London. A chaldron is forty bushels, or a cart-load.

Can you state how much dust and ashes in a year a house of given size generally produces on an average—take the house of a tradesman in Tottenham-court-road, who is there all the year?—I have often gone over the houses in Tottenham-court-road for I think the parish of St. Pancras is about one of the fairest that we can take, for they are nearly always in town. I think that, on an average, it is about a load and a half in a year.

Of course the quantity would be greater in the case of a large house, supposing the inhabitants to remain in town all the year?—Yes.

But when you come to a larger scale of house it will not be always in proportion, because many of the people are out of town during a great part of the year?—Yes. Our dust in one division alone has fallen off 15 loads a-week in the division of St. Mary's, St. Marylebone, within the last fortnight, in consequence of people going out of town.

That observation applies itself to all classes of houses in different parts of London, of which the inmates periodically go out of London for a lengthened period?—Just so.

Can you state what is the difference in the quantity of mud and dirt of different kinds, arising from a macadamized and a paved road?—Macadamized roads are the greatest nuisances in London. Where we have one load off in dry weather, we have seven in wet.

What is the proportion between them and the paved roads?—There are two-thirds more dirt on a macadamized road than on a paved road in wet weather.

What is the proportion on the wooden roads?—The wooden work is generally the cleanest in London.

Is the manure more valuable that comes from the wooden roads?—The manure is neat; it is dried horse-dung, nearly some mud from the macadamized road is brought, and left on it in carriages, &c.

What you take off the streets upon those occasions is much

more valuable than what you take off a macadamized road?——
Yes, but there is not enough of it.

You state that the mud on the macadamized roads is three times as much as on the pavement—can you state how much less there is on the wooden road than on the pavement?——We have hardly had experience enough. I think I might say one-third, without any danger.

Do you find on the macadamized roads a great deal of ground granite?——Yes.

Have you been able to turn it to any account?——When we have got to dispose of it, we are obliged to mix it to pass it off, by a sort of moral fraud; for if a farmer gets what they call “mac,” they will not have it at all; they say it does no good to the land.

Has it never been used for cement, or in any way?——I think we have sold such a thing as three loads in the course of a year, out of some thousands of it.

Would it not suit brickmakers instead of sand?——No? it would not pass through a fine sieve.

Do you know what is the effect as manure of the common surface-cleansing of the stone pavement; do the farmers state what is the effect of it at all?——They do not use it alone.

It appears then that the cost of cleansing a given number of square yards of macadamized surface would be considerably more than for the same surface of pavement?——Certainly.

And the same surface of pavement would be a great deal more than the same surface of wooden pavement?——Yes.

Therefore, the contract for cleansing during the year would be a great deal less by the general adoption of wooden pavement than it would be with either of the others?——Yes; the difference is astonishing where the wooden pavement has come into operation.

Can you give any details of it?——Yes; there is Marylebone parish: at the present time Oxford-street is nearly all paved with wood; it is wood up to the corner of Vere-street; formerly it was all stone, and then the cleansing was done at considerably less, in proportion, the shoots and wharfs being now farther away than when the macadamized road or broken stone came into operation. I think it has made a difference this year alone of 500%. I should not like to have taken the contract, if Oxford-street had been macadamized, at less than 500%. more for the parish of Marylebone.

You mean that the saving is 500%. a-year by having wood?——I am sure it is.

Have you seen wooden pavement applied in any narrow streets or courts?——I do not think it is in any court in London.

You are aware that the more narrow the streets, and the poorer the place, the poorer the paving?——Yes.

Do not you think that if wooden pavement was adopted in narrow

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places, the water would fall off a great deal better than it now does in the narrow courts in St. Giles's, where there are now holes and filthy water lodging?—If the wooden pavement were laid in a court in a proper manner, in the way that I believe most parishes are in the habit of agreeing with the wood-pavement companies, at so much per annum to keep their work in repair, then they would be bound to go into that court, and keep it in a proper state.

If that was done, would not it lessen the expense of cleansing those places, because the rain-water would act regularly, and carry the drainage down the kennels?—Certainly, if the paving was laid properly.

Have you had experience in cleansing any place where the asphalte is laid?—No; I have only seen one piece, and that is on the road leading to Vauxhall Bridge.

May you not be defrauded by your own men of the refuse; may they not drop portions of it by the way, for instance, turn it down the gully-holes, and so on?—They are subject to very heavy penalties if that is done.

Are you not aware that that is done to a considerable extent, especially with a macadamized road?—As to the macadamized roads throughout London, whatever the parishes have saved to their nerves, as far as noise is concerned, they have certainly lost by the extra sewer-rate, for the mud will run down of itself. As soon as a heavy shower comes it washes away all the powdered granite.

Being in a liquid state, it affords facilities for the men discharging it in that way?—If they are inclined to do so. I myself discharged three men for doing that very thing.

Do you find any opposition on the part of the owners of the ashes to your carrying them away?—In the low neighbourhoods they steal them from us.

Are you still much troubled by what are called “flying dustmen?”—Very much, in Marylebone especially.

Is not the price of breeze reduced very much?—Yes. Three years ago I sold the ashes and breezes at 10s. on board at Paddington. I have not sold any this year on board, but I am selling them at Battle-bridge at 3s.

Formerly something was paid by the contractor, generally a large sum, to the parishes. Has not the reduction in the price of breeze occasioned you simply to undertake the street sweeping in return for the breeze?—No; we pay the parish of Marylebone a large sum for what we are now taking at Paddington for the dust of St. Mary's, which is the most western part of the parish. We pay them at the rate of 3s. 2d. per chaldron in the houses, and when I took the contract in last January, I had every reason to believe that I should have cleared 6d. a chaldron; that upon 3000 chaldrons would have been 1500 shillings, which for one contract I should have been satisfied with. But I am sorry to say that at

present I have no offer of anything near, or at most anything more than the money we are giving for it as it lies in the houses before we send for it.

Do you attribute that diminution in the demand to any diminution in the amount of building or brickmaking?—I attribute it to the depression in trade generally, and to the builders who were substantial men three or four years ago now using a great deal of flying paper, so that if I send in 100,000 bricks to a man, I get a bill from him, and I feel very nervous about its being taken up, and we have been obliged to keep our bricks back rather than sell at all.

As a general rule, does any of the refuse of the metropolis pay, and if so, will you state what portion of it does pay for its removal?—The dust is the only portion. The parishes have hitherto generally received more from than they have paid to the contractor; but this year, in consequence of the depreciation in the value of the dust, the parish of Marylebone pays the contractor. Two years ago the balance was 1850*l.* in its favour.

If it were all put up together, dust and night-soil, could you afford to pay for it?—We do pay for the dust, but the night-soil is out of the question. We charge 10*s.* for taking away a single load.

Then the night-soil is a dead loss?—It must be a dead loss to the proprietor of the house.

Do you pay extra wages to the men who get out the night-soil?—Yes, we pay so much a load to the men. For a fair night-job we send out five men and a cart, and I generally send a foreman with them when I cannot go myself, because I am very particular. I do not like such a thing as spilling it on the road, or the men getting drunk. We pay the men 6*d.* a load to each of the five men, and for an average job that is half-a-crown to each man.

How long do they work for that?—Till five in the morning generally; not quite so long as five, because it must be done by four o'clock.

Are they paid rather more in consequence of the employment being disagreeable?—A third more at least.

Do they drink a good deal?—Yes. It is a very disagreeable occupation, and I do not wonder at their drinking. We always charge so much for the men's allowance for liquor besides the wages.

Are they generally men of great strength?—They come in as lads; they come from the country about 16 or 17, and if once they get into a nightman's yard they never leave it.

Are they healthy in general?—I can bring very stout men that have been in it all their lives.

Do they live to a good age?—We have got a man now that is 67. They live to a good age in general.

It does not produce any disease tending to shorten life?—I cannot see any disease that it would produce.

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Do accidents ever occur in emptying those places, such as suffocation from bad air?—I have frequently been there at night, and never knew anything bad escape beyond an unpleasant smell.

No cases of the men suffering from fever?—No. The only noxious gas generated is a little sulphuretted hydrogen.

How do you dispose of the night-soil?—If we take home a load at night it generally goes away by the cart almost immediately, if we should be fortunate enough to get any person that will give 6*d.* a load for it; otherwise we take it to the man that I have mentioned, who bakes it.

Do the gardeners purchase it?—They would be glad of it, if they could get it.

It is not used extensively by market-gardeners?—I do not think they use a load in the course of a year. We supply Mr. Norris, of Isleworth, with about 50 barge loads of manure per annum, but he will not have night-soil. We supply him with street-sweepings mixed with horse and cow-dung. We contract with the coach and omnibus proprietors in the town.

You do not attempt to mix night soil with it?—It would be out of the question; we should have the whole neighbourhood upon us.

Do you pay the coach proprietors for the dung, or do they pay you for taking it away?—We pay them for the dung, and we buy cow-dung from the cow-keepers. If we did not get the dung we could not sell the street-sweepings.

What do you pay usually for the dung?—We pay on the average for the cow-dung, if we fetch it from the place, about 2*s.* a cubic yard, that is about a two-horse load.

How much for horse-dung?—I suppose about 1*s.* 6*d.* a one-horse load, fetched from the house.

You buy it for the purpose of sale?—We buy it for the purpose of making the street sweepings saleable.

What is the expense of the carriage of a cubic yard of any one of those materials seven miles out of town?—I should say, one twenty-fifth part of the produce of London in horse and cow-dung goes out by country carts, which bring in a load of hay, or a load of wurzel, or a load of clover, and take out a load of dung in return, and the rest goes away by the scavengers, and compost is made of it.

What is the cost of carrying it out seven miles?—We have not consumption for half of it within seven miles of London.

How do you send it out?—By barges.

There is scarcely any carried out by carts that go on purpose?—Scarcely in any instance, except half a dozen.

What distance do the farmers send for it?—They will send for neat horse-dung as far as seven or eight, or nine miles, or a little more, because they pay no toll.

How far does that manure, mixed with dung, go?—As far

as Rochester. We have sent some as far as Margate three or four years back.

Do you send up the river?—We send up the river as far as Richmond-bridge perhaps.

And by canal?—And by canal; but the trade on the canal is very bad; the charges upon the tonnage of manure are too high.

Then, practically, you do not send much by canal?—No.

What may be the length of distance from the metropolis at which manure from it is regularly used?—As much as eighty or ninety miles down the river.

What is the greatest length to which the distribution by carts goes?—The furthest point that I know is about Kensal-green Cemetery. There are some small farmers about there who take our street-sweepings.

Do not the market-carts that bring in hay take back manure as far as ten miles?—As far as Southall.

Then the distance to which you send by barge is down the river as far as Rochester, or as far as Margate, and up the water as far as Richmond?—We have a wharfinger at Kingston who sends for stuff to one of our Thames wharfs.

Is it the custom of the trade to send out any by the railways?—No. When the Railway Bills passed they never could have legislated for the farmers, as regards manure.

Are the charges too high to prevent it?—Yes; it is quite out of the question.

With respect to cleansing the populous districts inhabited by the poorer classes, and which you are bound to cleanse at certain times, are there any inspectors or persons appointed to see that they are done?—Yes; in every parish.

But they do not look much into those places; they look chiefly into the large squares, do they not?—I do not know. I never was so tormented in my life as I was in the parish of St. Giles's. I had as many as seven or eight letters a-day. When I have cleansed a place twice a-week, they have actually made complaints that such a place was not cleansed at all. When I have cleansed it on Monday, on Tuesday they would send and say that it was not cleansed at all. If such filthy places are allowed, if a set of narrow courts are allowed to be built that a horse cannot get in or out, you cannot wonder at anything happening. The people go there on account of the lowness of the rent.

Is the rent very low?—1s. 6d. a-week is perhaps the average of an apartment.

Do you know that they are as low as 1s. 6d. a-week?—I am sure they are.

Do you find in the poorer districts an increasing attention to cleanliness manifested by increasing importunity to the contractor, in case of any neglect?—It is not the inhabitants who complain, it is the inspector and churchwardens, and the clergymen.

Mr. William
Thorn.

The Rev. Mr. Tyler, the rector of St. Giles's, is one of the most indefatigable men living; he is always in the midst of those places.

With respect to animal refuse, such as dead animals, how is that disposed of—do you know whether your carts collect much of it? —It is impossible not to collect some of it from the various stalls, the fish-stalls and others; and with regard to vegetable refuse, the quantity is prodigious.

Are there slaughter-houses in your district?—Yes; but we are not bound to take out slaughter-house refuse; they have often come to us and asked us to do it, but I would never meddle with it.

Is there much sheep-killing in the butchers' shops?—A great deal.

What do you make of the vegetable matter?—It goes into the barge, and that is the only method of keeping the metropolis healthy. If we are prevented from shooting it into a barge on a wharf, where the tide comes up twice a-day, which enables us to send her away as soon as the tide flows, we cannot keep London clean.

With respect to the metropolis generally, you are clearly of opinion that a frequent removal of the refuse is indispensable for the maintenance of health?—I should certainly say so.

And that the retention of filth in any place is a cause of sickness? —When it decomposes it must be so.

Have you ever observed that fever cases have followed in places where there has been any collection of filth?—I never knew it myself. I was talking with Dr. Wray of Salisbury Square, who lived many years in the neighbourhood of a laystall at Whitefriars; I asked him seriously whether he ever knew a case of fever arise from it. He said he never knew a case at all. I never saw but one case, and that was in the neighbourhood of the Edgeware Road. Horse-dung had been shot there, and laid down for about two months under the kitchen windows. A young fellow came direct from the country, and in a fortnight he had a violent attack of typhus fever.

You are quite clear that regular cleansing would be of great importance to health?—Certainly; I do not think that any vegetable matter would hurt for three or four days, or until decomposition commenced, upon a wharf.

You mentioned a young person from the country getting fever from a collection of horse-dung in a decomposed state; in that particular case were other people exposed to it who did not take the fever?—Yes.

Much more exposed to it, perhaps, than he was?—They had been there for some years.

What may be the largest quantity that you have known to be accumulated in a laystall?—The largest quantity I ever had in a laystall was twenty barge loads.

How much may there be in a barge?—About forty-five cubic yards.

Do you know whether the sailors in the barges are at all affected by it?—No; they are a fine healthy set of men.

The people engaged in the work generally eat and drink well, and have plenty of exercise in the open air?—Yes.

They have very little to do with the miasma in a state of concentration?—There can be no concentration of miasma till it has lain a month.

Does the description you have given of your own mode of carrying on business as a scavenger and contractor apply itself to others in the same business throughout London?—Yes, I should say so; we are the oldest contractors in London.

Is there any variation in the terms of the parochial contracts; do any of them contract per load for the quantity removed, whilst others contract for the extent of surface cleansed, without reference to the quantity removed?—I do not believe it was ever contracted for by the load, except that in one instance the parish of St. George's, Hanover-square, contracted to have it removed by the load, and they removed it by pauper labour.

What quantity of pauper labour was used as compared with that of regular men?—Three times as much.

One of the paid men did three times as much as a pauper man?—Yes.

Are there not opportunities of fraud in contracts for removing at so much per load?—Most decidedly; you may have a small cart, and a defective one, so far as carrying the wet material or slop is concerned.

You say it would be an object of importance to you to have a place where you could shoot night-soil, if you could manage to have it near the river?—If it could be shot into barges it would be a very valuable thing.

If any arrangement could be adopted, by which night-soil could be carried in carts and taken into closed premises, or put into covered vessels from which no odour could escape, would not that answer your purpose?—Certainly.

Do you think you could meet any difficulties presented to you by the inhabitants, if you could show that it was impossible for any odour to escape, and if you could also take them round and prove it to be the fact in the event of any objection being made?—Then that would do away with all the objection, because I consider myself that, in a medical point of view, there is no injury resulting from taking night-soil through the streets in the middle of the night, when everybody is in bed, with their windows closed, and putting it on board a barge; there can be no more harm in putting it on board a barge than in putting it in a field.

Is the practice of using water-closets greatly extending from the higher classes of houses to the middling classes?—Yes.

Are you aware whether it has been extended at all to fourth-rate houses?—I should say that almost every description of house, ex-

Mr. William
Thorn.

cept small cottages, and fifth and sixth-rate houses, are provided with water-closets now. The plan they have of doing it is, they put the water-closet a little way behind, and then the water pouring away from the sinks and wash-houses passes through it, so that the water continually pouring down drives away the night-soil, and sends it down the common sewer.

Where is that done with the lower class of houses?—In the neighbourhood of Paddington I believe it is done.

In all those cases there is a communication with the common sewer?—Yes, of course.

If there is any rule or regulation that prevents a communication with the common sewer, it prevents the plan being carried out?—Yes.

If communications were facilitated with the common sewer, do you think that plan might be extensively employed in poor neighbourhoods?—It might be done; but then arises a question, as far as the public health is concerned, when we all have to drink the Thames water.

Is there any reason to doubt that the labouring classes would use water-closets if they were supplied with them in their houses?—It would be their interest to do so.

From what you have seen of London generally, do you think it would be desirable to erect public conveniences in different districts, for the accommodation of the public in passing?—I should say urinals most decidedly.

Do you think privies would be desirable in some places?—I cannot see any objection to it, because the police would prevent any bad conduct going on.

Do you find that the streets are more or less cleanly than they were formerly in particular districts, in respect to night-soil in the streets themselves?—There is only one part in the west end of London where there was any such thing. The Rookery, in St. Giles's was in a most filthy state, but now it will be completely done away with.

In the better districts is there much pollution of the streets by night-soil?—Not at all. In a respectable street such a thing would set the people all up in arms.

Do you think that some provision, either of public or private necessities, fit for the humbler classes, would diminish the pollution that arises from the neglect of such things at present?—I do certainly think so. I am sorry to see that in the upper part of Pancras there is not even an urinal; you may go up one street, and down another, and round half a dozen turnings, and not find a single place.

You think such a provision would be conducive to public health in populous districts?—Certainly.

Is urine at all collected as manure, or for commercial purposes in any way?—I know no case in London at all; but it would make very excellent sal-ammoniac.

REPLIES TO QUESTIONS FORWARDED TO THE CHAIRMAN OF
THE CLEANSING COMMITTEE AT EDINBURGH, ANSWERED BY
MR. ALEXANDER RAMSAY, INSPECTOR.

Mr. Alexander
Ramsay.

1. Have not some recent regulations been made by the Police Establishment, in conjunction with the Fever Board, to fumigate and cleanse the houses of every patient attacked with fever? If so, be so good as to furnish a copy of the regulations, if they are not considered private?

As no precise regulations have been adopted beyond what are contained in the following narrative of proceedings, I venture to lay them before you in the order in which they occurred, as affording a more distinct view of what has been done than could well be given in a different shape.

On the 28th of July the prevalence of fever was first brought under the notice of the Cleansing Committee of the Police Commissioners, who of that date authorized me to cause the walls of any stairs or closes which might seem to require it to be washed with quicklime, keeping particularly in view those situations where fever had recently existed, or was likely to prevail. Operations were, according to this authority, commenced on the 1st of August, and by the second week of September, 1212 different places were washed.

The process, however, seemed to have no effect in checking or moderating the disease it was intended to counteract; and on the 11th of September, in reference to a communication from the City Charity Workhouse, the Cleansing Committee recommended to the Police Board to have the houses in those localities where fever prevails whitewashed and fumigated. The Board happening to meet on the same day, and adopting the recommendation of the committee, instant measures were taken to carry it into effect. On the 13th a meeting of the committee was again held, at which a deputation attended from the Fever Board, who stated that, from the great number of fever cases, it was impossible for the latter body to undertake the cleansing and fumigating of the houses without additional aid. The Cleansing Committee thereupon recommended that the Committees of the Fever Board and Destitute Sick Society should keep a record of all cases, where whitewashing and fumigation were required, and granted authority to me to appoint such persons, and to purchase such implements and materials as might be necessary to carry out the object of the meeting, and requested the surgeon of the police establishment to give his aid in any case where it might be necessary.

You will thus perceive that there are no specific regulations on the subject; and, except in so far as they might be compulsory on those whose houses are to be cleansed and fumigated, I am not

Mr. Alexander
Ramsay.

sure but the work is more quickly and more effectively performed when left to the direction of one person not encumbered with numerous rules and restrictions.

Since the commencement of the cleansing and fumigating on the 14th of September, up to last night, 211 staircases, many of them consisting of five or six stories; 749 rooms, of all sizes; 180 closets; and 739 passages have been thoroughly limewashed; and about 260 apartments fumigated, exclusive of the 1212 places already mentioned.

2. In what manner is the fumigation effected,—how is the house cleansed,—and at whose expense?

The fumigation being a process not safely performed except under the eye of a medical man, has been intrusted to Dr. Tait, of the police, whose composition for fumigating consists of one part of black oxide of manganese to four of muriate of soda. For an apartment of ordinary size, about four ounces of this mixture is laid upon a common earthenware plate or basin, which is usually placed in the middle of the apartment, and about two ounces of sulphuric acid poured over it. The doors and windows being carefully shut, and the chlorine gas instantly disengaged, every crevice in the apartment is quickly filled. In eight or ten minutes the windows and doors are again opened; and if there are a number of houses requiring fumigation in the same neighbourhood, the process goes on nearly simultaneously in the whole, so that one person may fumigate a very large number within an hour.

The house is cleansed generally by a couple of men, whose implements are a common pail and a painter's whitening-brush of a large size. The pail contains a solution of lime in water, the lime being in its most caustic state, and of sufficient consistency merely to whiten the walls. It is very quickly applied, and when the workmen become accustomed to it, which they soon do, they put the inmates to very little trouble, and do not occasion the usual splashing about of the material, the fear of which creates an aversion to the operation in the minds of indolent and infirm persons not always easily overcome.

The cleansing is effected exclusively at the expense of the Police Board.

3. Is this fumigating and cleansing compulsory, and does it extend to the houses of all classes?

The fumigation and cleansing are not compulsory, and do not extend to the houses of all classes.

When one or two houses of a tenement occupied by the poorer classes have been cleansed and limewashed, many of the neighbours, gratified with the fresh smell of the lime, and its light and agreeable effect on the black and dirty walls, apply to have their houses also washed; and others, seeing with how little inconvenience to themselves it is accomplished and its agreeable effects, on their permission being asked, very rarely refuse.

What is the expense attending the fumigation and cleansing of a second and third-class cottage respectively?

Mr. Alexander Ramsay.

The expense is a mere trifle. On the 30th of this month 41 staircases, 28 rooms, 13 closets, and 57 passages, were cleansed and limewashed by 24 men under the charge of three overseers, whose joint wages amounted to 2*l.* 8*s.*; the cost of lime to 3*s.* 6*d.*, and allowing for tear and wear of implements 4*s.* 6*d.*, we have 139 places thoroughly cleansed and purified at an aggregate cost of 2*l.* 16*s.*, or a fraction less than 5*d.* each. The staircases, it must be remembered, vary in height from one story or floor, to six or eight. On a large scale, therefore, such as that in operation here, the expense of cleansing a second and third-rate cottage of two or three apartments respectively might not exceed 9*d.* and 1*s.*, and the fumigation of one apartment under 2*d.*

Has this practice been attended with beneficial consequences; if so, state how?

From the shortness of the time the practice has been in operation here, it is almost impossible *yet* to determine its effects. In the course of nearly 19 years' experience in the management of the lighting and cleansing departments of police here, however, I have had many opportunities of knowing the effects of lime-washing on former occasions. For although the police statute was partly prepared at a time when this city was threatened with cholera, and many useful clauses added, it is still lamentably defective in its sanitary regulations, and must ever be so, until medical police shall have a statutory existence as a distinct branch, yet, on occasions of excitement regarding epidemic disease, the police has always contributed more or less to the purifications which the times rendered necessary. Most of the cleansings which then took place were like the present, a stretch of the powers of the police, not sanctioned by the statute, justifiable only by the circumstance of the prevalence of dangerous disease, and liable, I have no doubt, to be interdicted by any interested person; and, from the want of all compulsory power, partial and comparatively inefficient in their operation. No doubt, however, in so far as they go, they will be attended with most beneficial consequences; for although the salutary effect expected from them has not yet appeared in a reduction in the number of fever cases, or in their abated virulence, from other opportunities I have had of knowing their effect, I have no doubt that the present limewashing will be attended with results as decided and satisfactory as on former occasions. On the fourth or fifth floor of a house within a short distance of where I now write, for example, the whole occupants of that floor, consisting of several dwellings, were attacked during the last severe visitation of fever in 1838, and the whole floor repeatedly cleared by the inhabitants being sent to the infirmary. A fresh set of tenants were no sooner inducted than the disease again broke out, and again the floor was tenantless. It was occupied and re-occupied

r. Alexander
Ramsay.

several times with similar results, till at last there was a difficulty in finding occupants on any terms. The proprietor lived in the country, and, beyond getting his rents, took little interest in the matter; but on being urged to get the whole floor thoroughly lime washed, he did so, and fever, till within the last month, has not been known in it since.

I have troubled you with a communication much longer, I dare say, than you desire, and probably much longer than is really necessary; but my conviction from all I have seen, and all I have heard, in the course of many years' experience, is so strong and decided as to the efficacy of quicklime-washing in removing disease that if carried out under a statutory enactment, along with a few other simple and effective regulations regarding cleanliness, under the direction of a stipendiary medical officer, the periodical attack of fever, with which all large towns are visited, would be much less frequent in their occurrence, and greatly less severe in their character. Indeed I am not without the hope that I shall live to see the appointment of a medical officer in every considerable town in the kingdom. As compared with the numberless advantages of such an appointment, the expense would be a mere bagatelle. Supposing a salary of 250*l.* a-year were allowed for his services, and that the dwellings of every poor person in such a town as Edinburgh were to undergo an annual purification, and that the entire expense fell upon the public, the cost, including a permanent corps of cleaners and every other expense, would not exceed 500*l.* a-year. The dwellings of a very large proportion of the poor are mere dunghills, and the salutary effects of cleaning the closes and other places where they live, out-doors, are in a great measure neutralized by the filth which prevails within. This serious evil would be removed by the appointment of a medical officer, and an organized system of cleaning, or causing their dwellings to be cleaned; while the moral effect of frequent visitations would be to stimulate persons of filthy habits, and to awaken a taste for and an appreciation of decency, order, and cleanliness.

Under whose superintendence are these regulations placed, and how is he made acquainted with the fact of fever having appeared in a house?

Regulations you will see, in one sense of the word, there are none; and the work is placed under my superintendence.

Generally speaking, there is no great difficulty in becoming acquainted with the fact of the appearance of fever. Besides being in communication with the Committees of the Fever Board and Destitute Sick Society, the men employed in cleansing soon hear of any cases of fever in the neighbourhood; for, although the people have sometimes an aversion to the introduction of the cleaning force into their own dwellings, they are always ready to direct them to those of their neighbours where disease is known to exist.

P.S.—October 9. I have omitted to state in its proper place

that in preparing the lime for whitewashing, a small quantity of chloride of lime is added—probably half a pound to a pailfull.

Mr. Alexander Ramsay.

There being a meeting of the Cleansing Committee this day, and also of the Board, I have laid before them the following abstract, which appears to me of sufficient importance to justify me forwarding it, as showing the very trifling expense of executing a large quantity of work of a very important description:—

	£.	s.	d.
From September 14 to November 7, the wages to men and overseers employed in limewashing and cleaning amounted to . . .	31	7	5
The cost of lime to	3	8	0
Implements, say	6	10	0
Chloride of lime, say	0	14	7
Together	42	0	0

During this period there have been limewashed and cleaned . 303 staircases.
898 rooms.
248 closets.
894 passages.

Total . 2343

The average expense of each is $4\frac{2}{10}$, or a fraction above $4\frac{1}{4}d$. each.

I shall be glad to furnish any further information in my power.

FURTHER COMMUNICATION FROM MR. ALEXANDER RAMSAY.

During the 19 years that you have held your present office have you had many opportunities of becoming acquainted with the habits of the poorer classes?

My attention has been long directed to the state of the houses of the poor, and I am convinced that without some summary powers on the part of the authorities the dwellings of the poor cannot be kept in a sufficient state of cleanliness to insure a proper degree of health. I have been very anxious to establish in Edinburgh a medical police for this purpose.

Have you considered the necessity of appointing an officer whose duty it shall be to attend to the cleanliness of the dwellings of the poor?

I think it highly desirable that an inspector of the dwellings of the poor should be appointed. The constant duty of such an officer would be to visit the habitations of the poor, especially where disease exists. The inspector ought to be a medical man, and for many reasons the execution of the measures he might consider necessary should not be in any way connected with the criminal police. One great source of efficiency of such a measure must be its popularity. The visitations from the criminal police would be very offensive, while those of a medical man would, on the contrary, be very popular. An officer such as I allude to would prove of infinite benefit to the health of a town.

Mr. Alexander
Ramsay.

Do you anticipate any particular benefits from the appointment of a medical inspector?

Such an appointment would possess many advantages, many of them not very apparent at first sight, besides that of a sanatory inspection of the houses of the poor. For notwithstanding the numerous means in operation for their benefit, in the pious ministrations of the clergy, the unceasing and unwearied attentions of the medical profession, the benevolent labours of charitable societies, the laborious superintendence and administration of the parochial funds, there is no responsible stipendiary officer whose labours among the poor possess the advantage of centralizing their wants and necessities in one common focus. Such an officer would at all times afford a ready and effective means of communication with all public bodies, or individuals, whose objects are the relief of destitution, disease, or misery. For even in cases where there is no disease, the amount of privation endured from mere want of knowledge where to apply for relief, and the want of means and intelligence to make application for it, is greater than may be easily conceived. In cases where destitution is aggravated by disease, the appointment of an officer who would procure for them the aid which their circumstances might require would be the means of relieving a large amount of human misery. Those who spend much of their time among the destitute poor can tell how often it happens that the unfortunate subjects of fever are forsaken by friends, relatives, and acquaintances, and for days together left wholly in solitude, altogether without human aid, and frequently without the miserable comfort of a cup of cold water. Unfortunately this is no exaggerated picture, but one of every-day occurrence; and until means are established for insuring in sickness and in health a regular inspection of the houses of the poor, by a paid and responsible functionary, it must continue so.

The first duty of such an officer would be a constant inspection of the dwellings of the poor, with a view to the prevention of disease. It would be his duty to cause such dwelling-houses, stairs, areas, or other places as might seem to require it, to be properly cleansed and fumigated, either at the public expense or that of the private party, as the judge acting in the police court might determine.

In cases of fever or other infectious disease occurring in densely-inhabited or ill-ventilated situations, he would see that medical attendance was obtained, cause their houses and apartments, the bed-clothes and bedding, as well as the persons and body-clothes of the inhabitants, to be cleansed and purified, and generally take all needful measures to prevent the spread of the disease.

A duty of not less importance would be a constant surveillance of that class of lodging-houses occupied by beggars, hawkers, strangers, and other persons having no fixed place of residence. The crowded and filthy state of these lodging-houses, particularly,

for some time before and after harvest, the nasty state of their beds, frequently occupied by promiscuous intercourse of the sexes in poverty, rags, and filth, many of them labouring under dangerous and infectious disease, the nightly succession admitted to the same apartments, the same beds, and the same bed-clothes, with their wandering and unsettled mode of life, present a condition of things as favourable for engendering and diffusing disease as it is well possible to conceive.

The simple and obvious remedy for this state of matters is, in the first place, to compel all keepers of lodging-houses of this description to occupy them under a licence from the police court, upon a certificate from the medical officer, stating the number of lodgers each apartment is to contain, with a due regard to health and decency, and to affix a copy of the licence on some conspicuous place on the wall of each apartment, and making the householder bound to report to the officer of health, or police, every case in which any inmate shall have been confined to bed by illness, of whatever nature, for more than 24 consecutive hours. This, with a due attention to the proper cleansing of the houses and bed-clothes, would go far to remove many of the evils which adhere to lodging-houses in their present state.

Now, one professional gentleman at the head of the sanatory department, with several overseers, and an intelligent subordinate assistant, would be quite sufficient for a town like this, and they would be able to attend to other matters connected with the prevention of disease, as well as with its amelioration when the disease occurs.

Would you think it desirable to render it imperative upon the officer of public health to visit every case of death, and unless a certificate of its cause was left by the medical attendant of the deceased, to institute strict inquiries into the cause, and to register the latter?

For very many reasons such a system would be highly desirable.

In the answers which you have already forwarded, you have described the mode of cleansing apartments after fever. Would you be inclined to put this under the direction of the medical inspector?

Certainly; and there should be as few legal difficulties as possible to the execution of his orders. When the medical officer finds it necessary that the staircase, apartments, or other places require to be cleansed or fumigated, a simple printed notice specifying what is to be done, and allowing a particular time for carrying it into effect, affixed upon the walls of the premises, should be held to be a sufficient legal notice, and if not complied with, may be done at the expense of the inmate. In other cases where, from the poverty of the inmates, the state of disease in the house or neighbourhood, or other causes, it may be necessary that the cleansing should be immediately effected, the medical officer should have the power of having it done without delay.

Mr. Alexander
Ramsay.

Are you quite convinced of the beneficial results arising from limewashing houses in which fever has existed?

Since the commencement of limewashing by the police I have been at the utmost pains to ascertain whether any case of fever has occurred in any house previously subjected to limewashing. A number of cases were reported as having occurred, but on inquiry it turned out that the whole of them were the cases of relapse.

Have you formed any calculation to show what would be the expense of an establishment for such a purpose?

I have done so for the city of Edinburgh, and perhaps you will accept this as an example. In Edinburgh there are 10,098, say 11,000 houses, at and under 4*l.* rent; one-fifth of the occupants of them are in such circumstances as to be beyond the necessity of requiring public aid; one-fifth more are cleanly and orderly in their habits, and would not require public assistance. Now, supposing the cleansing to extend to houses under 4*l.*, and allowing 1000 houses in which cases of fever may occur in dwellings above that rent, where the parties could not afford to cleanse for themselves, the aggregate amount of houses to be cleansed would be 7600. The cost of cleansing each separate place is 3½*d.*, but in order to include staircases, lobbies, and such like places, let us take the cost as high as 7*d.* each, include also in the above calculation the expense of 2400 fumigations; then the total cost for cleansing and fumigating annually 7600 houses would be 221*l.* But this calculation is based on the assumption that a special cleansing corps were retained for the purpose; by taking advantage of the services of the ordinary scavengers in the performance of this work the expense will be greatly reduced. By far the greater part of this work would have to be done in the summer months, when the ordinary duties of scavengers are very light; two-thirds of the whole work might therefore be performed by them without interfering with other labourers. This would reduce the expense to 175*l.*

Suppose that the surgeon at the head of this department were to have 250*l.* per annum (although no doubt that sum is too small for a highly qualified medical officer, but the salary might be increased afterwards, when the measure became popular); his medical assistant to receive 80*l.*, and as the 175*l.* includes the salary of one permanent attendant, such occasional assistance as may be required, and the whole cost of implements and materials, then the whole expense of this medical police for Edinburgh would amount only to 505*l.*

Do you consider the outlay would actually prove a great economy by reducing the burdens on public charity, and the expenses attendant on disease?

Certainly so; but the amount of benefit to be derived from the institution of such a system is not to be calculated by the mere

amount of pecuniary saving, although even in that point of view the saving would be enormous. The relief of disease and destitution before they become increased and aggravated would not only be a great means of diminishing mortality, but would enable hundreds of families to provide for their own support who, by delay in procuring relief, become long and frequently permanent burdens on charity. It is thus clear that the pecuniary saving would be immense, and this, together with the physical and moral effects arising from the system, would be all purchased at a sum of 505*l.*, being upon the rental within the bounds of police under one-third of a penny on the pound.

In the event of a medical police being established throughout the country, do you think they should be subject to a central control, or be placed under the authority of corporations, or other local public bodies?

I am decidedly of opinion that a central control would be of great importance, in order to furnish the means of comparison with other towns, and also to obviate the evils arising, especially in the case of public nuisances, from the interests of those being affected who had the power of dismissing the officer from the appointment which he held. Free and independent action, as far as regarded the town, with at the same time a proper responsibility to an unbiassed body, would be of the utmost importance to an officer of public health.

You are also the superintendent of the scavenging or cleansing of Edinburgh, are you not?

Yes, I am superintendent of the scavengers employed in cleansing the city. Under me there are eight overseers, I myself being responsible to the Commissioners of Police.

What are the regulations for cleansing the town?

All the streets in the town are cleansed; in fact, I may say the whole town is cleansed every day. The narrow confined closes or wynds are cleansed several times in each day. The total expense of the cleaning departments is nearly 12,000*l.*, but the sale of manure decreases to a great extent this expense. On the average of several years the sale of manure has yielded 10,000*l.* per annum.

Are such courts and alleys as are inaccessible to carts cleansed by the public scavengers?

Courts and alleys of every description to which the scavengers can find access are cleansed; all of them are cleansed once, many of them several times, in each day. In addition to the sweeping of these places, the carts go round every morning through the whole bounds for the collection of refuse; and in the old town and poorer districts also at half-past nine in the evening, and on Saturday night over the whole bounds.

How is the manure disposed of, and at what price?

From 20,000 to 30,000 tons of manure are annually disposed of by sending it to farmers by means of the Union Canal. The

Mr. Alexander
Ramsay.

remainder is sent to farmers in the neighbourhood by the Edinburgh and Glasgow, and by the Dalkeith Railways. We deliver it free of expense on the banks of the canal for 5s. 3d. per ton. We have only two depôts for the manure, both of which are situated nearly a mile out of town.

What number of scavengers and of carts do you employ?

The number of scavengers vary from 100 to 130, according to the season of the year. The wages which they receive are 12s. per week. The number of carts employed is about 50 per day.

Under what regulations is the night-soil removed?

Night-soil is removed by our own scavengers or nightmen, between 10 at night and 6 in the morning, and is disposed of with the other manure; the night-soil is vested by Act of Parliament as police property.

From your experience in the cleansing department, do you consider that the cleansing of courts and the removal of night-soil should be intrusted to public scavengers, and not, as in many towns in England, to private individuals?

If there be any one point which I should wish to impress upon you strongly, it is this to which you now allude. If you allow private individuals to remove night-soil, it will never be regulated or efficiently performed. All matters connected with cleansing should be put under the public authorities, or their responsible officers.

Mr. J. Whitworth. MR. JOSEPH WHITWORTH, on the Cleansing and Construction of Roads and Streets.

ARE you the inventor of the road and street-cleansing machine?

Yes, I am.

How long has this machine been in operation?

The first principal trial of it was made on the 13th February, 1841, when we took off from a surface of 2772 yards, 12 loads, or 14 tons of dirt in 6½ hours, being one load for every 231 yards. This experiment was made in Portland-street, Manchester, and sufficiently convinced us of the capabilities of the machine. Since then it has been brought into regular operation both in Manchester and London.

Have you contracted to cleanse the township of Manchester by means of your machine?

I have; the agreement into which I and my partners have entered is, to sweep the streets twice oftener than under the old system, at an actual saving to the town of 500l. per annum; or, in other words, we are to receive for doing twice the amount of cleansing 500l. less than the former expenditure.

Have you entered into similar contracts with other towns?

We have contracted to cleanse the township of Chorlton-upon-Medlock, and the wooden pavement in Regent-street, London.

Our machines are also used in the city of London, but not under Mr. J. W. i'worth. our own management. This line of road includes wooden pavement and Macadamized surface. We have also undertaken to sweep a sixth part of the City, including Fleet-street, Ludgate-hill, Farringdon-street, &c.

Describe the nature of your invention?

The principle of the invention consists in employing the rotary motion of wheels moved by horse or other power, to raise the loose soil from the surface of the ground, and deposit it in a vehicle attached. The apparatus for this purpose consists of a series of brooms suspended from a light frame of wrought iron, hung behind a common cart, the body of which is placed near the ground for greater facility in loading. As the cart-wheels revolve, the brooms successively sweep the surface of the ground, and carry the soil up an incline or carrier-plate, at the top of which it falls into the body of the cart. The apparatus is extremely simple in construction, and has no tendency to get out of order, nor is it liable to material injury from accident. An indicator, attached to the sweeping apparatus, shows the extent of surface swept during the day, and acts as a useful check on the driver. It also affords the opportunity of working the machine over a given quantity of surface.

State the average amount of work which your machine can perform, as contrasted with the number of men necessary to execute the same amount of labour?

The average rate of effectual scavenging by hand in Manchester, taken for a whole year, is from 1000 to 1500 square yards of surface daily for each scavenger. The manner of sweeping is different in London, and therefore an apparently larger amount of work is done, but not so effectually. When the machine is in operation, the horse going only $2\frac{1}{4}$ miles per hour, it sweeps during that time 4000 square yards; thus performing in a quarter of an hour nearly the day's work of one man. The average amount of surface which can be swept by a machine during the day depends upon the distance of the places of deposit. In Manchester we have seven places of deposit, and the average number of yards swept daily, by a machine drawn by one horse, is from 16,000 to 24,000.

Do not these places of deposit prove a nuisance to persons living in the neighbourhood?

The circumstances under which the refuse is now collected prevent the occurrence of any nuisance. Formerly, the intervals between the collections of refuse were so distant as to give time for that deposited to become offensive. But now those parts of the town which were cleansed on the old plan once a-month, are swept by us three times a-week; so that the refuse is fresh, when brought to the place of deposit, from whence it is removed on the average of once a-fortnight. In fact the drainage of the yards and stacks is so complete, that there is no perceptible effluvia arising from them.

Mr. J. Whitworth. What peculiar advantage do your machines possess when compared with hand-labour?

In answering this question I will, with your permission, avail myself of a Report we published some time since, and quote from pages 8 and 9, as follows:—

“ The process of street-cleaning consists of three parts, viz., sweeping, loading, and carrying. Under the present system these are entirely distinct operations; each of them constitutes a protracted and expensive process, and the two former absorb a large amount of human labour. By the aid of the patent machine, all the three processes are not only carried on simultaneously, but, as it were, blended in one operation, whilst each is so far simplified as to render the combination less complex and protracted than the single process of either sweeping or loading by the present mode.

“ By the present mode of sweeping, the dirt is first moved from the centre to the sides of the street, and there collected into heaps for convenience in loading. An immense amount of time and labour is thus consumed; the mass of dirt being moved over a wide extent of surface, and the operation of cleaning continually retarded by the accumulation. It is calculated that each particle, on the average, moves through 20 feet of space before the operation of loading commences.

“ Here the advantage of the patent machine is self-evident. It entirely supersedes the whole process just referred to. The dirt, instead of being swept from one part of the street to another, is swept at once into the cart, and the street is cleared effectually. The operation of sweeping, in fact, merges in that of loading, and both are performed without the intervention of human labour. When going at the rate of only two miles per hour, with brooms three feet wide, the patent machine will clean nearly 60 superficial square yards per minute. This is about the average rate of work done by 36 men.*

“ While the machine is thus calculated to abridge human labour, it will have the effect also of reducing the number of carts and horses now required to perform a given quantity of work. The time at present occupied in loading and carrying is considerable, in consequence of these operations being performed under very unfavourable circumstances.

“ That of loading must be suspended during the progress of the cart from one station to another, and consequently is perpetually interrupted. Horses and men are stopped and started alternately at short intervals, whereby a continual waste is occasioned both of time and force. The operation of the patent machine, on the con-

* In the township of Manchester, 22,000,000 yards were swept during the year 1841. 60 sweepers and 20 carters were employed, of whom, say 67 were constantly occupied in sweeping or loading.

This would give 1,000 yards per man per day. The labour of paupers is found to be much less effective.

trary, is uniform and uninterrupted. Hence, though taking less in width, it will go over double the extent of surface included in the progress made by the present cart during the same time. Moreover, the diminished time occupied in loading is made available also for the purpose of carrying. By the present mode the cart must stand idle, while being filled, whereas the patent cart not only combines the operations of sweeping and loading, but performs both in the act of moving forward to the place of deposit. Mr. J. Whitworth.

Nor is this all; it also economizes the time now spent in carting away and returning empty. "Under the present system, owing to the great width of surface from which the sweepings are collected, the cart cannot travel far without being filled, and hence the time is principally occupied in carrying merely. Probably two-thirds of the whole time of carts, horses, and drivers are thus consumed, even where the places of deposit are adjacent. But the patent cart, taking less in width (as before observed), will proceed proportionably further before it is full. If the street be 20 yards wide (the brooms being one yard) it must go ten times further, and would reach a distant point by the time it was completely filled. Hence it may be practicable to make such provision for deposit within or near the district as will save nearly all the time now consumed in carrying. A very moderate number of depôts would suffice for this purpose. If the streets were kept clean by frequent sweeping in dry weather, the yards might be advantageously placed more than a mile apart, and the cart passing from one to another would continually carry on its threefold operation.

"Under any circumstances it will have the effect of reducing the number of carts and horses now required for a given effect, besides doing all the work in sweeping and loading. It might be supposed, from the extra duty thrown on the horse, that an increase of horse-power would be necessary; but it is to be remembered, that under the present system the horse works at a great disadvantage; his force is spent in alternately starting and stopping, standing idle, and drawing the empty cart.

"Besides the direct economy of manual labour and horse-power, the use of the patent cart will be attended with other advantages not unworthy of notice. Owing to the complication of the present system, it is unwieldy in management. The different processes, though distinct, are mutually dependent, and must be adjusted to each other. The number of sweepers must be in a certain proportion to the number and return of the carts, that the operation of loading may follow immediately on that of sweeping. It is true that this object is rarely accomplished; but the mere attempt, which is compulsory by law, involves a superfluous outlay, and tends to perplex the whole management. The improved system will be entirely free from this cause of embarrassment, each cart acting independently, and having, in connexion with itself, all the necessary accessories."

Mr. J. Whitworth. What is the relative expense of the two modes of cleansing?

In Manchester the average expense of sweeping and carting away the refuse of 1000 square yards, is 4s. 6d. The cost of sweeping by the machine varies according to the distance of the places of deposit. In Regent-street, London, where we sweep early in the morning, and deposit the refuse in the street for removal by the contractor, we have charged 14d. per 1000 square yards. Generally, the cost of sweeping and removing the refuse to places of deposit by the machine will be from one-half to one-third the price of scavenging on the old system.

Is the machine applicable to every kind of street surface?

Perfectly so. The kind of surface does not make any difference. It has been worked regularly on every kind of street surface; the round and square set stones, the macadamized road, and wooden pavement.

Does the machine cleanse the channels of a street or road?

We have latterly constructed all our machines to clean out channels. A modification of the original form of the machine enables us to sweep up to the curb-stone and so effect this object.

For the effectual cleansing of a town, is it not of the utmost importance that the channels should be well constructed?

Certainly. Very many advantages would result from a proper form and construction of street channels. In the old streets of Manchester, and many other towns, the large round boulder stones were employed in the construction of channels. The consequent irregularities in surface (occasioned by the varying form of the stones) render the proper cleansing of such channels a matter of great difficulty, and prevent a proper flow of water, which lodges in the cavities along with the refuse it holds in suspension, and soon proves offensive. But now the Paving Committee form all new streets as well as the channels of square-set stones. These are often too broad, so that if they get a cant on one side, an irregularity in the channel is occasioned. They are also frequently placed without sufficient care, and left in too rough a state for the free flow of water. Until very recently the channels in this town were not laid down to the regular curve of the street, but were made to clip towards the curb-stone, so as to form a gutter, or they were placed in the reverse way, according to the very objectionable method practised in some parts of London, by which the road is elevated towards the curb-stone, so as to form a gutter with the curve of the road. My opinion as to the form of channels coincides exactly with the specifications of Telford, where it is stated,—“There should be no gutter or other channel but that which will be formed by the angle made by the surface of the pavement abutting on the kerb-stone.” One great advantage of this form of channel is, that the road or street may be used up to the curb-stone. Such a form of channel is much more easily

cleansed than a gutter, and is quite as favourable as the latter for the free flow and escape of water. With respect to macadamized roads in towns, there is great difficulty in getting the road rendered firm towards the curb-stone, as carriages do not in general approach sufficiently close to press down the stones. The consequence is that the loose stones obstruct the free flow of water, and prevent the channels from being cleansed. I therefore think it would be of great importance in towns where channels require such constant attention, to pave the macadamized streets for 12 or 18 inches from the curb-stone. Mr. J. Whitworth.

How often has it been usual to cleanse the streets in Manchester?

The regulations for scavenging under the old system were, that first-class streets should be swept once in a week; second class streets once in a fortnight; and third class streets once in a month.

Now as the necessity of cleansing depends upon the amount of traffic (except in streets consisting of cottage property), is not a specific provision of this kind inadequate for the purposes intended by cleansing, and actually in opposition to a proper economy of labour?

Decidedly so. For example, some of those streets which are entered in our contract to be cleansed once in the month, may not require to be swept throughout, more than once in the time specified. But as local accumulations of refuse take place during the whole interval, it is more consistent with proper cleansing to remove these as they occur. Thus, though we may not go over every part of a street more than once in the month, we cleanse the streets in parts several times each week, thus affecting a more efficient cleansing by the distribution of the labour performed. It is the same with those streets entered in our contract to be swept once a week, as we generally find it necessary to send the sweeping machine through them every morning. Hence, although the period in which a street is to be cleansed should be fixed, the labour ought not necessarily to be performed at a given time, but might with much advantage be distributed over the period described.

In the present form of courts and alleys your horse-machine is of course inapplicable.

I am now preparing a hand-sweeping machine for courts and alleys. The great disadvantage of sweeping these by ordinary scavengers is, that the men require so much supervision to prevent them doing their work in a slovenly manner. But the indicator attached to the machine shows what surface has been really swept. This machine will also be applicable to foot-paths, and to the filthy alleys between the back doors of two contiguous rows of houses. Such a machine, however, involves the expense of manual labour, besides the derogatory effect to men, of being employed instead of beasts of burden. Hence I intend to have a small machine so constructed that a pony may be able to draw it. In

Mr. J. Whitworth, future arrangements for new courts and alleys, it would be important to consider the facilities for cleansing, as well as those for ventilation. If courts were kept open at both ends, a small width would be sufficient for cleansing them by the horse-machine. But if they are formed with a cul-de-sac, to admit a cart, they should be at least four yards wide. For the sake both of cleanliness and ventilation, a width to enable a cart to turn would be of great importance, but it would be still more advisable to prevent them being blind alleys or cul-de-sacs. Hitherto courts and alleys have been considered as independent of public scavenging, but they really ought to be made the objects of special attention, and cleansed every day. I have given particular orders to our men to take the channelling carts daily into all the poor thoroughfares through which they can pass.

Does not the frequent cleansing of a street actually diminish the amount of refuse to be removed?

In some kinds of pavements and roads very much. This effect is produced in various ways:—A large quantity of water is retained for a long time on the surface of dirty roads, and of course increases the mass of matter to be removed. Moreover the water thus retained settles down into the foundations of the road, and causes the soil beneath, when pressed and shaken by the traffic above, to rise between the sets to the surface, thereby occasioning an additional increase of waste matter. In the town of Leeds, where soft yielding substances, such as cinders, are used for the foundation of the pavement, this is strikingly the case. Again, the accumulated dirt and water on the surface of roads greatly increases the waste of the superficies. When a lapidary desires to grind a stone, he places upon it moistened dust of the same stone, and it is thus quickly worked down. If he took a clean polished surface it would produce little effect. Hence the greater attrition on roads occasioned by wheels grinding with the aid of refuse lying on them, causes a more rapid waste than if this refuse were removed and a clean, dry, and hard surface left for the wheels. This applies with peculiar force to the case of macadamized roads. In illustration of the greater amount of waste upon dirty than upon clean roads, I may cite the following instance:—

By the Tables of Scavenging, published in the Reports of the Manchester Police Commissioners, in 1841-2, the extent of sweeping was greater by 8,000,000 of square yards than in 1838-9, while the number of loads was less by 14,000. The extra loads removed in the former year must have consisted principally of water and subsoil, of which the quantity in the latter year was diminished by more frequent cleansing. Part of the diminution in the refuse collected must be attributed to the better kind of pavement and materials used in the foundations; but still there cannot be any doubt that the principal saving was from the first reason stated.

The following facts published by the Commissioners, placed in Mr. J. Whitworth, the form of a table, will illustrate the above remarks:—

District.	No. of Yards Swept.	No. of Loads Removed.	Average No. of Yards per Load.
Township 1838-39	13,500,000	39,409	343
Township 1841-42	21,500,000	25,029	859
The portion swept by machines } the latter year }	5,574,000	1,285	4,338

In the case of pavements, consisting of square-set stones put in with lime, such as those in London, attrition on dirty roads causes a certain amount of increased waste, but the results are not so marked as in the former cases, in which soft yielding foundations work up through the joinings of the pavement.

As frequent cleansing diminishes attrition, would it not prove economical to cleanse frequently by promoting the durability of streets and roads, and by preventing the necessity of frequent repairs?

Unfortunately I am not aware of the existence of data for exact calculations on this subject; but the tendency of cleanliness to promote the durability of streets, and consequently to diminish the expense of repairs, is so great, that even under the present system it would be decidedly economical to clean them oftener. When dirt is allowed to collect on the surface, the water, as before observed, is prevented from running off, and sinks down to the foundation, which, becoming soft, yields to the first pressure. The surface of the street is thus rendered uneven, and the injury, though slight at first, is continually augmented; carriage and waggon wheels revolve in the hollow places with the violence of concussion, and the soil underneath rises between the stones to the surface, causing a new settlement. In the end the structure of the street, which otherwise might have lasted unimpaired, is completely broken down.

Would there not also be an economy in lessening the draught of horses, and diminishing the wear and tear of vehicles of all kinds.

Without doubt this must be the case, and the following experiments stated in Sir Henry Parnell's work give evidence of the fact:—

On a paved road the draught	= 2
On a well-made broken stone road in a dry clean state	= 5
On a well-made broken stone road covered with dust	= 8
On a well-made broken stone road, wet and muddy	= 10
On a gravel or flint road in a dry clean state	= 13
On a gravel or flint road in a wet and muddy state	= 32

As keeping a road in perfect repair is so intimately connected in an economical point of view with its cleansing, would it not be of great importance to consolidate these trusts, putting them under one body instead of two separate bodies?

That would be of great importance, as the additional amount expended in cleansing would be saved in the diminished waste of the road. They are, in fact, so intimately connected, that they ought not on any account to be separated.

Mr. J Whitworth. In towns there are generally three bodies, possessing powers of taking up pavements, viz., Commissioners of Sewers, and companies for supplying gas and water. Would it not be advisable, by a consolidation of trusts, to make the Paving and Sewerage Commissioners take up and relay, at the expense of the companies, the pavement when required?

Decidedly so. The present system is a great nuisance; for the companies, repairing in the cheapest manner without reference to the period of duration, do the work in a much worse way than a paving board, whose interest it is to keep the streets in proper repair.

You stated that your machine was applicable to wooden pavements. Do not their transverse grooves offer obstacles to their proper cleaning?

The late introduction of the patent street-cleansing machine on the wood pavement in Regent-street has led my attention to the different modes of grooving such pavement now practised; and I am of opinion that the adoption of longitudinal grooves only, where the inclination of the road is not very considerable, would be found to answer generally the purposes required, much better than any of the various modes now in use. The principal conditions required in a paved surface are, first, the least possible quantity of friction and concussion, in order to produce smoothness of motion and easy draught; and secondly, sufficient adhesion for the feet of horses employed thereon. Besides these may be mentioned the durability of the pavement, and the facility of cleansing and repairing it. In all these respects, grooves running in a longitudinal direction only will be found advantageous. The diminution of friction which would be thereby obtained, and the entire removal of that concussion which is now occasioned by cross grooving, must be sufficiently obvious, as also the consequent smoothness of motion and economy of horse-power, with the increased durability both of the pavement itself and of the vehicles employed on it. The only question that can arise regards the hold the horses will have with their feet on the surface. In this respect, also, there will be found to be a decided advantage in the proposed arrangement of the grooves. It is to be considered that grooves in one direction only may be repeated at half the distance from each other at which they are now placed, without diminution of the surface, and the nearer grooves of any description are together, the greater the security.

Again, it would appear that the tendency of horses to fall down is greatest when slipping in a lateral direction; and if so, the longitudinal grooving would in this respect afford them better support than cross grooves. But a still more important effect would be, the absolute certainty the horse would have of the kind of surface on which he was about to place his foot. Cross grooves, if wide apart, are of comparatively little advantage even for draught, owing to the uncertainty under which the horse labours, of being able to avail himself of them without slipping. At the distances they are now placed apart, the chances are much against his gaining any advantage, and hence the force he must exert against the ground

must be sufficient for the draught, independent of the cross grooves, Mr. J. Whitworth. on account of that uncertainty. Cross grooves are proper for steep ascents, and they should then be used exclusively, and placed nearer together. Grooves in various directions, at the distances they are now made, render it impossible for the horse to know how to act so as to avail himself of their assistance. In consequence of the narrowness and roundness of some gig and carriage wheels, perhaps the longitudinal grooves should not be more than three quarters of an inch wide, say half an inch deep, and five-eighths of an inch broad at the bottom, having all the corners rounded. As the durability of wood pavement is so great, we may safely say 2 inches for the distance between each groove. This will give for a wheel 2 inches broad, $1\frac{1}{4}$ inches of rolling surface, when the centre of the wheel is over the centre of the groove; for a 3-inch wheel, under the same circumstances, $2\frac{1}{4}$ inches of surface; and for a 4-inch wheel, $3\frac{1}{4}$ inches. When the wheel is over two grooves, a 3-inch wheel would still have 2 inches bearing, and a 4-inch not less than $2\frac{1}{2}$ inches.

In cleansing, the advantage of the longitudinal grooves would be very great, as the brooms would encounter no obstruction in sweeping out the soil accumulated. The necessity of having so much water laid on the street would be obviated, and a great saving effected in the expense now incurred. It would only be when wind accompanied great dryness that a small quantity might be required. The grooves should not be more than half an inch deep, on account of the greater facility with which they will be cleaned; nor does a greater depth seem necessary, as but little wear takes place. When they do become too shallow, a machine drawn by a horse may be employed for deepening them, which no other plan of grooving will allow, and this may become in time a matter of importance.

I have suggested two inches as the distance between the grooves. This may be thought too little. Rankin's proportion of groove to surface is about 1 to 3. But it must be remembered, that the grooves being in a longitudinal direction only, the wear and tear would be very considerably diminished. In a word, the two opposite conditions required by the horse and carriage are each fulfilled with the least degree of mutual interference, by a system of longitudinal grooving. Most of the foregoing remarks will also apply to stone pavements.

Paving stones should be 3 inches wide, and from 12 to 18 inches long, and they should be laid lengthwise in the street. The ends should be well dressed and made quite square, for close joining, to prevent concussion. The sides dressed in the ordinary way would form a sufficient groove at their junction. A pavement of this kind would answer exceedingly well on a level, or at a moderate inclination.

A general impression prevails that wooden pavements are more easily cleansed than stone; is this impression correct?

Mr. J. Whitworth.

The contrary is the fact. The wood generally used for paving purposes being very porous, and the fibre vertical, or nearly so, the manure, when pulverized by the action of the wheels, becomes so imbedded in the fibre, and adheres with such tenacity, that it is impossible to remove it except when either very wet or dry. The power required for cleansing it is also much greater than for stone, and we consequently find that a horse cannot cleanse an equal number of yards per day on wood pavement. A much greater quantity of rain is required to cleanse it well, and it is much longer in drying; hence the time afforded for efficient cleansing is of much shorter duration than in the case of stone pavement. Still, by constant attention, and more especially where there is sufficient width of street, a considerable degree of cleanliness can be maintained, as may be seen in Regent-street. The difficulty of cleansing wood pavement would be materially diminished by the adoption of longitudinal grooving.

Is the expense of cleansing by machine materially increased in wet weather?

The cleansing of streets and roads is most advantageously and effectually performed after rain, while the mud remains in a liquid state. It is of great importance that every such opportunity should be turned to account, and that every facility should be afforded for this purpose. In sweeping with the machine, the liquid mud is taken up with the greatest ease, and a perfectly clean surface left. The only disadvantage which arises consists in the large quantity of water taken up with the soil, which soon fills the machine-cart, and greatly increases the expense of removal to the deposit. In hand-sweeping this evil is, in a great measure avoided: the mud being first swept to the sides of the street, the water finds its way through the channel into the gutter, and a comparatively small portion is put into the slop-waggon. To facilitate the working of the machine in this essential respect, it is proposed to provide mud-tanks in suitable situations. They might be sunk in the centre of broad streets behind coach-stands, say six yards long by three yards wide and two yards deep, and covered over with moveable wooden pavement. The interior to be provided with escape-pipes for the water, having plugs at various elevations, and communicating with the common sewer. In wet weather the machines might conveniently unload into the tank, and the solid deposit be afterwards removed during the night. This would be attended with no inconvenience to the public, and would more essentially promote the efficiency and economy of cleansing by the patent machines. If such a provision were made, it would not only be available in wet weather, but also in that muggy state of the atmosphere, when, owing to the presence of considerable moisture, the soil on the surface of streets becomes so thick and viscid in consistence that it is impossible to sweep and almost impossible to scrape it. If, when in this condition, a certain portion of water be thrown over the soil from the watering-cart, it becomes liquified

and may be removed with the same ease as in wet weather; the advantage of the mud-tank would therefore be very great in facilitating this operation. There would be no objection to this plan on the ground of obstructing the flow of water in sewers, for only liquid matter would be allowed to run from the tank, and this would add to the efficiency of the refuse for irrigation. If an effectual system of flushing sewers were introduced, the lighter refuse might be swept down; but I question whether it would be advisable to do this with solid sweepings from macadamized roads.

Mr. J. Whitworth.

No kind of street or road surface can be properly cleansed when the dirt is in that sticky or clammy state which is produced by the presence of a certain proportion of moisture. The continuance of this unmanageable condition, so unfavourable to traffic, depends on a great variety of circumstances,—the state of the atmosphere, force and direction of the wind, influence of the sun, the nature of the materials of which the road and its foundation are composed, their mode of construction, and, more particularly, the actual state of the surface as regards repair and cleanliness.

If it be full of holes and covered with dirt, the continuance of that particular condition of the superficial matter above referred to will be indefinitely prolonged, during which period all effectual cleansing will be impracticable.

CLEANSING OF MILAN, AND APPLICATION OF THE REFUSE TO AGRICULTURE BY IRRIGATION.

Application of
Refuse at Milan

THE city of Milan consists in three concentric circles, two of which are formed by canals constantly provided with flowing water, and the other by the town walls.

The inner canal, or *Sevese*, which is the most ancient, encloses the first nucleus of the city under the Romans, is all covered, and serves only for drainage. The other canal, or *Naviglio*, which forms the second circle, encloses the city as it was during the middle ages, is open, and serves for navigation as well as drainage. The *Sevese* carries off the drainage of the two inner circles, and the *Naviglio* that of the external.

All the streets of the city have along the centre a subterranean sewer in brick-work, and proportionate in its dimensions to the body of rain-water it is intended to receive, considering the length of the street and the depth of the houses on its sides. The rain from the front roofs is collected in vertical pipes fixed to the walls of the houses, and runs through subterranean gutters into the longitudinal sewers of the street. The rain from the back roofs and courts, as also the waste water from offices, provided it be absolutely liquid, flows in the same manner into the street sewer. But the houses along the two canals discharge at once into these, not only their liquid drainage, but every sort of half liquid material proceeding from water-closets and laboratories.

Application of
Refuse at Milan.

The drainage of the city being thus carried to the *Sevese* and the *Naviglio*, either by the street sewers or direct by the gutters of the neighbouring houses, the street sewers are levelled according to the depth of the canal into which they discharge their contents.

The administration of the drains of Milan is divided into three branches,—viz., the street sewers, the *Sevese*, and the *Naviglio*. Being myself the surveyor of the *Sevese*, or covered canal, I will give you an account of the administration of this department—that of the *Naviglio* being conducted nearly in the same manner:—

The houses and premises emptying their drains into the *Sevese* form a district, and their proprietors form a society; the society is represented by a committee, elected by the proprietors. The members of the committee are renewed at the end of every two years. The committee consists of 12 members and a president who is changed every year. The president enforces the resolutions of the committee. The committee transact the ordinary business of the society by a majority of votes. The extraordinary business is referred to a general meeting of the proprietors. The committee is assisted by a surveyor, a cashier, a secretary, an overseer of the works, and a solicitor.

The assessment of the rates for the maintenance of the *Sevese* is made once in nine years; the surveyor inspecting all the houses of the district, and taking down the quantity and nature of the drainage, as well as the length and depth of each house fronting the canal, whenever any alteration has taken place in consequence of division of property.

In order that the quantity of earthy deposit may be easily ascertained, the level of the *Sevese* is marked by a number of blocks of granite fixed along the bottom. The *Sevese* is cleansed twice a year, in April and September—periods at which the water of the canal is turned off. The cleansing is executed under a tender, by piece-work, and not by measure. The repairs are also done under tender, but at so much per given measure, and for each separate work.

The estimate of expense for these works is made every nine years, by the surveyor, upon the sum spent during the nine years preceding, and on present emergencies. The rates are proportionate to the quantity of drainage. The assessment of rates for the maintenance and cleansing of the canal is deduced from the three points:—1. The estimate of expense for the next nine years. 2. The divisor of the estimate. 3. The resulting quota which form the unity of assessment. The divisor of the estimate is proportioned to the frontage of the houses placed along the canal, and to the quantity and nature of the drainage discharged by them. The other houses of the district, the drainage being represented by a certain number of square feet constituting the quota of each house. The houses are, therefore, assessed in proportion to their frontage and to the particular nature of their drainage. Accordingly,

slaughter-house for oxen is rated 76 feet; a slaughter-house for cows and pigs 56; dye-houses, water-closets, hotels, dairies, and generally all premises not comprised in the first two categories, 38 feet; a stable, containing from 1 to 4 horses, 19 feet; a stable, containing from 4 to 8 horses, 38 feet; ditto containing from 8 to 16 horses, 56 feet; a private house 19 feet; a court-yard 11 feet; a pump 7 feet.

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According to an old custom, founded on the greater or lesser use of the canal, the houses facing the canal in the most populous quarter of the city are assessed in proportion to their actual measure in feet; the houses fronting the canal in the less populous part are assessed at two-thirds of their actual measure; and the houses built over the canal are rated as a double frontage, in the same proportions.

The Sevese derives its water from the Naviglio, by means of three inlets—one of 17 inches, the other of 10, and the third of 6, in three separate spots. These waters are then collected by another canal, called Vetra, which, after receiving another contribution from the Naviglio, assumes the name of Vetabbia.

The Vetabbia flows out of the southern part of the city, and, after a course of 10 miles, discharges itself into the river Lambro, fertilizing prodigiously a considerable extent of meadow land. It can be easily conceived what must be the fertilizing quality of the Vetabbia, as it carries off all the filth of a city of 150,000 inhabitants, and the quantity of fertilizing matter borne along by its waters raises in such a manner the surface of the meadows it irrigates as to render it necessary that from time to time the deposit should be removed from the meadow in order to preserve the level of irrigation. The deposit is by itself an excellent manure, and is bought by the neighbouring agriculturists as a fertilizer. The Vetabbia possesses also the valuable peculiarity of protecting from frost the meadows it irrigates, owing to the high temperature it receives in its passage under the town.

The Cistercian monks were the first who turned to a profitable use the slimy waters of the Vetabbia, and introduced the system of irrigation, which forms a most important branch of the agriculture of Lombardy.

The waters of the Naviglio, after receiving the drainage of the remainder of the city, are also applied to the irrigation of an extensive surface of land.

It may, perhaps, not be useless to add a short description of the water-meadows which in Lombardy are called *marcite*. These meadows are divided into various rectangular zones about 22 feet wide, by means of rectilineal channels, which serve alternately, one for irrigation, and the other for draining. These zones are arranged so as to have a slope of about six inches from the channel of irrigation to the draining channel. The waters of the feeder, which is placed on one of the sides of the meadow at a right angle

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with the channels of irrigation, flow into these, and through the whole of their length spread over the zones on both sides, covering them, as it were, with a watery veil, which preserves the life of the plants and promotes their vegetation. The water of the draining channels is then collected again into another channel, which conducts it to irrigate another meadow in a similar manner. The *marcite* are irrigated in summer during a certain number of hours about once a-week; and from the end of September to the end of March they are irrigated permanently, the water being only turned off when the grass is cut. During winter the irrigation of the meadows is also carried on with spring water, which land-owners are authorized by law to conduct to their lands through the lands of their neighbours. To this very ancient law a great portion of the agricultural wealth of Lombardy is to be ascribed.

Some of the meadows irrigated by the sewerage-water of Milan yield a net rent of 21*l.* per *tornatura* (a measure of 10,000 square metres, equal to about two acres and a half), besides a land-tax of 61 francs 10 cents, the expenses of administration, repairs of buildings, &c. These meadows are mowed in November, January, March, and April, for stable-feeding; in June, July, and August they yield three crops of hay for the winter; and in September they furnish an abundant pasture for the cattle till the beginning of the winter irrigation.

Mr. James Dean.

MR. JAMES DEAN examined.

HAVE you, in your capacity as land surveyor and civil engineer, and in connection with agricultural drainage, paid considerable attention to the disposal of such refuse of towns as is usually carried away in the sewers, to agricultural production?—Yes, I have.

Have you not specially considered of the practical means of applying all or part of the sewage of the metropolis to these purposes?—Yes, I have, with the assistance of my son, who is now engaged in one of the largest works ever undertaken, the drainage of Haarlem Mere, in Holland.

Will you state any facts coming within your own experience or observation as to the amount of agricultural produce obtainable (by the application of such refuse as that discharged in the sewers of the metropolis) to agricultural production?—I believe that where grass land yields one mowing crop and feed, by the application of sewage to such land, it would produce two, and in some seasons, three crops, and at least double the quantity of feed. This may be effected by the liquid sewage, after having deposited

the grosser particles into properly formed settling ponds or reservoirs. The solid portions collected in such ponds would then be applicable to the manuring of arable as well as grass land, to which it might be removed by carts, or in some situations by boats from the settling pits. The value of this solid portion when carried to the farm and mixed with the road-side soil, with scrapings of roads, and with the banks of enclosures next to the ditches, seldom productive in the natural situation, but of great value when so mixed with the solid matter of manure so collected.

Would you apply the liquid sewage to the land by the water-cart, or in what other way?—Where there was a fall from the settling ponds, by irrigation; where there was no such fall, by water-carts, to be pumped up in like manner as in well-regulated farm-yards formed to preserve the liquid manure, and in extensive cases by steam power, especially when, from the drainage, large quantities of water might be accumulated.

To what instances of practical application would you refer as exemplifying your views?—To Ashburton and other towns, especially in Devonshire. At Ashburton they have carried on this practice more than 40 years within my own recollection. They have grass for the ewes and lambs a full month earlier than in most other situations that are not similarly circumstanced, and at a time when lambs produce double or treble the price they usually sell for at other periods. Land similarly circumstanced to this, except in the application of the town manure, produces rushes, *carex*, and the stoloniferous grasses, commonly known as of the tribe to which the *florin agrostis stolonifera* belongs. The due application of such sewage, producing or promoting the growth of the poas, the fescues, and especially the vernal grass, all of them abounding in nutritive matter, consisting of sugar, mucilage, and extract, and the other requisites necessary to the feeding and fattening of cattle, and increasing the quantity and improving the quality of milk.

What is the general value of such land when unimproved, and when improved?—Unimproved and situated near to a town, is usually worth from 30s. to 40s. per acre; when so improved is worth from 8l. to 12l. per acre.

Then the application of the refuse of towns to grass land not only increases the quantity but improves the quality of the produce?—It improves it exceedingly. But for such improvement the drainage of the land must be coincident with the irrigation. The ground must be made dry for the application of such refuse, otherwise the additional produce will be coarser.

You are aware that it has been objected to the use of irrigation that the produce obtained is generally coarser than that of the ordinary growth?—Yes; but I am also aware that the irrigation is often unskilfully applied. I would lay it down as a practical axiom that irrigation will always improve land, provided it is sufficiently drained. The produce will often depend much on the

Mr. James Dean. quality of the water used, whether issuing from the chalk, which is generally of a superior quality for irrigation, or whether derived from the clay slate, mica slate, granite, &c., which is generally inferior, being destitute of the calcareous principle. Water so derived and applied directly, produces a coarse vegetation: but if it be exposed in ponds for a considerable time (where it imbibes the ammonia of the atmosphere) its quality will be improved, and it will produce a better description of vegetation, and in greater quantities. I have practically, by the adoption of this mode, changed the produce of irrigated meadows. Water, no matter what its quality, will render land productive, if improved by exposure to the atmosphere.

In respect to irrigated meadows, when irrigated with only common water, you are aware that objections have been made to their formation in the immediate vicinity of towns, it being alleged that they have the effect of marshes, and increase the damp, and give off a marsh miasma, which is injurious to health: do you consider the objections of this class well founded?—I do not. This will never occur, no matter what the soil, if the ground be well drained in the first instance, the surface-drains for rendering the land dry being used for carrying off the water after it has lain a sufficient time on the surface to saturate and give off its chemical properties to the grass. Water coming from higher ground should lie a sufficient length of time to deposit the soluble matter brought down from the arable land. When it is limpid it should be drawn off. Of this an intelligent farmer or expert irrigator will judge without difficulty, and with certainty. If the water gives off fixed air, which occurs when air bubbles float on the surface and which is the time at which it gives off miasma which is injurious to the health, that is the time at which the water should be drawn off, for then it begins to be injurious to the land.

In the cases where common irrigation have produced such miasma, has it not then been from the ignorance or the neglect of this principle of management?—Yes, either from one or the other, or from both.

Then you consider that the channels of drainage and the channels of irrigation should be made subservient to each other?—Yes; and provided that care be taken that there be no irregularities in the bottom of the feeders and the bottom of the drains, very little fall will be necessary to effectuate both. I lay great stress on the necessity of the careful formation both of the drains and the feeders. This may in all cases be ensured if the workmen be instructed in the use of boning rods, using them at short intervals. A more important duty could not be performed by any surveyor having the superintendence of either drainage or irrigation than the instruction of the workmen in the use of boning rods. Town as well as land drainage frequently fails from the neglect of their proper use.

The question put to you in respect to the sanatory objections to irrigation in general had reference to irrigation by common water. It has been objected to the application of the refuse of towns to agricultural productions, when such refuse is conveyed in water and applied by irrigation, that such irrigation is often the more injurious by the addition of the emanations from decomposing animal and vegetable substances to the common marsh miasma. Do you conceive that such objections may be obviated?—The certain and necessary means of obviating the objection would be to carry all such matter in closed drains to some place at a distance where there are no habitations near, and where settling ponds could be conveniently formed; where the soil could be deposited to be carted or boated away in the direction of demand, and the water used for irrigating the grass land near. This refers, however, to the existing mode of cleansing towns, and not to one in which the refuse will be immediately diluted in water.

Will the better formation of water-meadows for the reception of such liquid refuse and its better management abate the offensiveness of the miasma that might otherwise arise from it?—With the precautions I have pointed out in respect to the application of water to cultivated lands, I think any such evil as that apprehended may be entirely obviated. If the land be deeply drained and permeable, there will be an immediate absorption of the refuse, more especially by the fibrous roots of the plants growing on the surface. This was the effect produced with the application of the refuse of the town of Ashburton by irrigation upon the estate of John Caunter, Esq. The refuse was not, however, carried out there in closed drains, as I would propose as an invariable rule in all cases where there is not an immediate and abundant dilution of the refuse with water. I have generally referred to the instance of the town of Ashburton, to show what may be done with refuse by irrigation.

What distances from habitations do you consider would prevent injury and obviate objections to the escape of miasma either from settling ponds, or any occasional escapes from the liquid refuse when first spread over land in the process of irrigation?—If the outfall from the town be in an easterly direction, from a furlong to a quarter of a mile; if in a westerly direction, then a quarter to half a mile, as the wind most usually blows from the west or south-west, on the average of nine months in the year. If rising ground intervene, that would shorten the distance. The proper dilution of the refuse before its application to the land, that is to say, the dilution which is necessary to render the refuse the most productive, would, in that part of the process, generally prevent the escape of any miasma, and at all events such escapes would only be occasional, and of very short duration.

You are aware that in the neighbourhood of towns, fields and gardens are occasionally top-dressed with town or stable manure.

Mr. James Dean. For example, Hyde-park has been top-dressed with stable dung, which, for a time, emitted offensive smells; and the amount of offensive smell, as indicating the extent of decomposition, (it is stated in evidence,) indicates the extent of escapes of gases injurious to whoever is exposed to it. Now, if the same quantity of dung, instead of being so applied in the solid form as top-dressing, had been put in solution or suspension in water, and applied in the liquid form to the surface of the park by means of water-carts or by irrigation (supposing that practicable), or by any other mode, what would have been the comparative escape of miasma, so far as you can judge?—By the application of the refuse in the liquid form, the emanations would be inconsiderable as compared with the emanations from the top-dressing.

In the liquid form how long a time would the emanations generally continue in the ordinary state of intensity?—When applied in the liquid form on a drained and permeable soil, and at a temperature of about 60, the emanations would not last above a day. I presume in all cases that the land is properly drained. Even if the refuse were applied by water-carts which would be in a state of concentration, not to make the expense of cartage too heavy, the absorption by the plants would remove the emanations in the course of the day.

Under favourable circumstances as to weather, in how short a time might the emanations from the top-dressing of stable dung on the Park have ceased?—In about six days if the temperature were below 60; if the temperature were above that, the decomposition would be more active, and would go on for a longer time, until the substance itself had disappeared.

That is to say, by the application of manure as top-dressing, and in the solid form, much more is and would have been given off as emanations injurious to the public health, and less left to be absorbed productively by the land as manure?—Yes; the process would go on until the substance was almost worthless as manure.

Then the process of receiving and applying the refuse in water, of diffusing and separating the particles in water, so as to render them more immediately and directly applicable for absorption by the plant, is the best process for reducing the amount of escapes of emanations injurious to the public health, and of avoiding the dispersion and loss of valuable material of production?—Yes, certainly it is so.

Is this applicable as a principle to the whole of the decomposing animal and vegetable refuse, night soil, or other matter, as well as stable dung, that may be conveyed away in suspension or solution in water through the channels for the house-drainage, and street-drainage, and cleansing of towns?—Yes, certainly.

Where water is not available in sufficient quantity, are there any modes of saving the productive matter used as manure, but

which escapes from the decomposition of that matter or those substances when exposed on the land as top-dressing in the neighbourhood of towns and villages?—Yes, if, when such matter as stable dung or farm-yard manure be applied as a top-dressing to the land, about 5 bushels of prepared or roasted gypsum, or 10 bushels of *slaked* lime, or two hundred weight of nitrate of soda, were added (at the time of carting out to be spread) to the quantity usually deemed necessary for the top-dressing of each acre of land, the ammonia of the manure would be neutralized or fixed, and consequently the escape of miasmata prevented.

Mr. James Dean.

Would not this process be profitable to the agriculturist, independently of any consideration of the health of the population exposed to such emanations?—Yes, there is no doubt that it would be profitable to the farmer or market gardener. If the admixture takes place at the time of spreading (which is most important to observe, for if it be only mixed and carted out to remain in heaps, the benefit would be much less), the fertility of the manure is in ordinary seasons nearly doubled by such a combination.

To what casualties are the applications of manures as top-dressing exposed from the weather?—To almost entire loss of that which constitutes the food of plants. If there be a heavy and continuous fall of rain, the most productive portions of the manure would be washed away from the surface of the land into the adjoining ditches or water-courses. A long-continued frost in a great measure destroys the value of the manure. It locks up the ground, and it dissipates the ammonia. A long-continued drought and hot weather, as in the present year, dissipates the ammonia by a more active decomposition.

By receiving and keeping such refuse in water, the amount of loss from emanations is then not only diminished, but the disintegration necessary to the productive application of the refuse, is rendered more complete, and the time of the application greatly shortened, and the chances of loss from adverse weather diminished?—That is true, and is certainly an important principle to be constantly borne in mind.

You have stated that one day would in general suffice for the absorption of the liquid manure; whilst six days at the least would be necessary for the absorption of as much of the manure as could be absorbed from it when applied in the solid form as a top-dressing. With arrangements, such as might be practicable for the application of manure in water, would not a favourable day be chosen for its application, and the valuable manure be placed at once, or during that day in security amidst the roots of the plants in the permeable soil, whilst by the last process of top-dressing it is exposed to the atmosphere, not only to the loss of the six days' emanations under the most favourable circumstances, but to all the adverse chances of losses, such as you have described?—

Mr. James Dean. Yes, that is most certainly the essential difference of the two processes.

In respect to the difference of productiveness of irrigation and top-dressing, instances have been adduced where land, by the use of stable or town manure as a top-dressing, have only had the ordinary produce increased one fold under favourable circumstances, whilst portions of the same land lying convenient for irrigation have had the produce increased at the least five fold by the application of the same manure in the liquid form. Do such instances coincide with your own observations?—Yes, decidedly.

Since the different rates of production would appear to be somewhat coincident with the different rates of the escapes of the emanations under the two processes, may it not be fairly concluded, that these different rates of production represent the comparative sanatory value of the two processes, one, if properly conducted, being five or six times more valuable than the other, in the vicinity of towns, or amidst habitations?—Yes; my experience confirms that view of the question, and is deserving of the most serious and general consideration.

In this country the application of manure to production by diffusion in water over meadows formed to receive it by the mode of irrigation, has, it appears, been applied chiefly to grass land. You are aware that abroad gardens and arable lands have been watered, if not manured by irrigation. Have you met with any instances which would lead you to believe that the manuring of arable land might be rendered practicable, and made cheaper than the process of manuring such land, with liquid manure by means of the water-cart?—I have known some instances, where the land has been favourably circumstanced, where the water has been applied to drill crops, such as peas, beans, and the usual garden products, with which it was very successful, especially with strawberries, producing more abundant crops, and much earlier than could have been obtained by any mode of top-dressing. In hilly districts, as in Devonshire, I have no doubt that irrigation might be applied most successfully in this manner, and would be vastly improved by the refuse of towns.

Suppose a given quantity of manure has to be spread on the land, what will be the expense of the labour of applying that manure in the solid form as top-dressing (that is, the cartage spreading and bush harrowing, &c.), as compared with the expense of spreading the same quantity of manure in suspension in water or in the liquid form, by the mode of irrigation?—The expense of distributing the same quantities of manure, irrespective of the different degrees of productiveness from the different modes of application, would be, on the average, for distribution in the solid form, about 3*l.*, and in the liquid form, by irrigation, about 6*s.* The expense of “drowning,” or spreading the water by irrigation, is usually for the labour about 1*s.* per acre each time.

In situations where there is not the convenience of the fall of Mr. James Dean. any upland water to resort to to ensure the advantages of this mode of distribution of manure by irrigation, will not those advantages pay for the application of steam power to lift the water for the purpose to any height from which it may be distributed. You are aware that large quantities of water are raised at such rates as 1s. for lifting 80,000 gallons 100 feet high for the expense of pumping?—I have no doubt of the applicability of steam power, and believe that it will be applied to an extent now little thought of for these purposes. In respect to the removal of the refuse of towns and its distribution, I have no doubt that steam power must be used and will overcome many difficulties. As locomotive steam-engines are now coming into use and are let out for thrashing corn and other purposes, I have no doubt that similar applications of steam power will be found advantageous for irrigation as well as for drainage.

It is stated by Mr. Whitworth that each of the twenty-four street-sweeping machines in use in the streets of Manchester sweeping about 20,000 square yards of street surface daily, usually pick up about six one-horse cart loads of dung each cart on the average, or upwards of 120 loads of dung per diem from the streets; and that a daily sweeping of such streets in the metropolis as Regent-street gives on the average about two loads of dung each day for each quarter of a mile of street. He states that he already finds the farmers near Manchester willing to pay more for dung which is swept daily, because they find that it is as they term it “fresher,” and proportionately more productive. Now will not the proportionate loss which you have stated to arise from the decomposition of the solid refuse, and its escape by emanations when spread out as top-dressing and exposed to the sun, serve in some degree to measure the loss from emanations of the productive value of the manure every day, that after it has fallen it lies, from neglect of cleansing, spread upon the surface of the streets?—Yes; varying with the condition of the atmosphere in the town, its greater warmth and stagnancy, and other circumstances facilitating decomposition.

So that what the farmer gains in “freshness” and value from the immediate removal of manure, the inhabitants of the town gain equally in the avoidance of the injurious and offensive emanations, which makes the streets smell like close stables, especially when newly watered, during a hot summer’s day?—Yes, certainly.

Would not the addition of gypsum and the other chemical ingredients which you recommend as desirable to fix the ammonia, and prevent its escape from top-dressings, be equally necessary to prevent such escapes and losses from the same manure when remaining spread out as it were in top-dressings on the streets and open spaces of towns, and to protect the health of the inhabitants

Mr. James Dean. from its emanations?—Certainly; it has been recommended that gypsum or chalk should be spread on the floors of stables or shippens in which beasts are fattened, to fix the ammonia and protect the health of horses and neat cattle.

Would the quantities of gypsum you have mentioned be equally effectual for all kinds of manure?—No; night-soil, and the refuse of slaughter-houses and animal matter, such as are kept for days in towns, would require much more, perhaps double the quantity, to fix the ammonia.

In respect to this kind of refuse, would not its immediate reception and its removal in water equally serve to prevent or arrest decomposition and the escapes of productive valuable material, to protect the public health, and render such a process as that you have described for fixing the ammonia less necessary?—Certainly. I need scarcely add to what I have already stated, that top-dressings with night-soil or with the refuse of slaughter-houses, or with other animal matter, will be much longer in giving off offensive emanations than top-dressing with the common stable and town manure, and consequently will be the more injurious to the public health.

You now find that the same circumstances which affect the health of human beings affect the health and condition of cattle?—Yes. The effect of emanations from decomposing animal and vegetable refuse, as horses and cattle which are kept in close, ill-ventilated, and ill-cleansed stables, is, first to depress their appetites and general condition, and put them off their feed: then, if they be kept for lengthened periods in such stables or feeding-houses, low fever follows, leading on to various forms of inflammatory attacks and epidemics, such as have been so destructive amongst cattle in this country during the last three years. I was on the veterinary committee of the council of the Royal Agricultural Society, formed to investigate the subject of these epidemics, and, from all that I saw and heard, I came with other members to the general conclusion, that the great amount of loss was occasioned by the want of a proper supply of water, bad cleansing, bad drainage, and the want of proper ventilation. The epidemic was certainly the most destructive in the worst conditioned places in these respects.

Do you recommend sanatory appliances for the preservation of cattle?—Yes; a sufficient supply of pure water, very careful drainage; and that every drain entering a stable should have a stink-trap, and that there should be a superior exit for the escape of the vitiated air. In these places the drains are generally defective, much too small, and untrapped.

You are aware that neither house-drains nor street-drains are generally trapped?—The population ought most certainly to have the like protection, and the manure which escapes as a gas ought, moreover, to be saved for the sake of agriculture.

You are aware that some of the worst marshes, the most ill-drained and worst conditioned land in the country, is in the immediate vicinity of the towns?—It is generally so; and generally for this reason—that the lands contiguous to towns are more subdivided amongst different small proprietors and amongst poor persons having rights of commons. The more numerous and smaller the class of proprietors, the less the chance of any agreement amongst them, especially if the land is within or connected with any Parliamentary borough, where there is a right of voting.

Will you give an instance of a town where the adjacent land is undrained and in a state of marsh, giving off emanations injurious to the health of the town population, the state of the surplus water being at the same time injurious to agricultural production?—I might give several instances of populous districts along the river Lea. I will submit the instance of the village, as it is called, of Tottenham, where I reside, which has a population of 9000. Close to this village there is about 400 acres of land in a state of marsh. Amongst the population bordering upon this marsh, there has been an extraordinary amount of fever during the last twelve months, and the Board of Guardians are continually applied to for relief in these cases. On this subject I have already made the following statement:—

“There is, however, I lament to say, one drawback on the high character of this otherwise exemplary parish, and a very serious drawback it is, the want of powers to compel the cleansing of the open sewers and drains, which so materially affect the health of those who inhabit between the turnpike-road and the river Lea, in the precincts of the marshes. After cold wet springs, and dry hot summers, there is generally malaria floating over the low wet lands; that has been the case this year, and when the stench of neglected drainage mixes with the malaria, fever and bowel complaints, especially among the poor, follow.

“Heretofore the surveyors of the highways have caused the main sewers and drains to be scoured and cleansed, by compelling the occupiers of the land adjoining to do the work, or pay for it; the Act of Parliament authorizing that course of proceeding was, a few years ago, repealed, and the General Highway Act contains no such provision, *empowering* only the surveyors to scour, cleanse, and keep open all ditches, gutters, drains, or water courses, adjoining, or lying near to, any highway, but is not compulsory on them to do so; hence, most unaccountably, have the present surveyors neglected this most important work. They have twice appeared before the bench of magistrates upon summons; have admitted that what is complained of by the Board of Guardians and others ought to be removed, and have repeatedly promised the magistrates that it should be done forthwith, but to this hour, now more than a month, since they first appeared before the magistrates, not one step has been taken to abate the nuisance. The magistrates feel that they have no jurisdiction under the provisions of the existing Act of Parliament, and recommend indictment; but to try an indictment might cost double the sum that would remedy the evil complained of, and with

Mr. James Dean. considerable uncertainty as to the result, since the statute is only *enabling*, and not compulsory on the surveyors. The only power the magistrates appear to have over refractory surveyors, is under the 11th section of the 5th and 6th William IV., chapter 50, to dismiss them from their office for neglect of duty, and appoint others in their stead. The magistrates have used every means in the way of persuasion to induce the surveyors to abate the nuisance; have assured them that they will pass their accounts as regards cleansing and scouring the sewers and drains in question, if objected to by any parishioner, which is not probable, but all to no purpose; they contumaciously persevere, contrary to their solemn promise, in opposing the anxious wishes of the Guardians of the Poor, and the written declaration of the medical officer of the Union, that to the deleterious effect of the exhalations and effluvia arising from the non-cleansing of the drains and sewers in question; fever and cholera has for some time been raging in their immediate vicinity, producing dismay among the inhabitants, and occasioning an increase of expenditure in the poor-rates, far exceeding in all probability the amount which the cleansing and scouring in question would cost the parish."

The next village, Edmonton, is similarly circumstanced, and I believe that there are other cases of the kind along the river Lea. Indeed the evidence published in the Sanatory Report shows that similar evils to towns from the want of drainage of the land in their vicinity prevail to a very great extent.

What are the road surveyors, of whom complaints were made in respect to the state of the sewage?—One, the leading surveyor, is a butcher: another is a retired grocer: two others are, I believe, farmers.

Men, it is to be presumed, having no knowledge of engineering or drainage, or science or skill applicable to the drainage of a district?—They are respectable men, but certainly possessing no knowledge, or science, or skill applicable to drainage.

What may these 400 acres of land be worth per annum in their present state of marsh?—About 30*s.* per acre.

What would this same land be worth to the owners if it were drained, and relieved from the surplus moisture, which is so injurious to the health of the population living near it?—If it were drained it would be worth 3*l.* per acre.

What are the obstacles to its drainage?—It is chiefly Lammas land, and in small pieces. Not one twentieth of the householders entitled to Lammas rights, derive any benefit from it whatever. A few cow-keepers turn out cows upon it: higglers, and other persons keeping horses, turn their horses upon it. No respectable farmer; no one who possesses any stock which he values would send it on these marshes for fear of the diseases they would be liable to catch, or from their getting kicked or lamed.

Of course this land gets no manure?—Nothing, except what the cattle leave upon it. It is flooded about twice in the year after heavy and continuous rains.

And after the flooding comes disease?—Yes; formerly it

was ague, now it is fever. It must be stated as justifying a confident opinion as to the effects to be obtained by better land drainage, that in the district near Tottenham, as well as in other parts of the country, the imperfect drainage that has already taken place has improved the climature altogether; there is less of cold, less of fog, less of ague and rheumatism, in the parts where the improvement has taken place. Formerly the cold morning fogs in the spring and autumn ranged from eight to ten feet high near Tottenham; where the drains have been opened by cleansing, scouring, and deepening, they are not half the height. I speak of a district at the foot of Stamford Hill, heretofore known to coachmen as the coldest between London and York. By further improvements I believe that the evil may be entirely removed. It has been my remark in travelling from one end of England to the other during the last forty years, that fogs diminish in number and in height in proportion to the drainage. The drainage which has been carried on in South Holland, in Lincolnshire, has reduced the fogs to full one-tenth of what they were forty years ago. The diminution of these morning colds and fogs have a very beneficial effect on the alacrity and industrial habits, as well as the health of the population. Fever and other diseases from the decomposing refuse left to accumulate amongst the more populous districts, now takes the place of the rheumatic attacks and the intermittent fevers that were formerly prevalent. Arrangements for the drainage of the low lands and the clearance of outfalls are now becoming of greater importance, as the upland drainage becomes more extended, for sudden floods become heavier and more frequent, and do more damage, owing to the insufficiency of the original outfalls. Some serious damage was recently done, and loss of life occasioned, by floods on the low lands of Stratford, on the river Lea; and the defence of the bailiff and marsh jury to the charge of neglect to open the sluices and repair the banks of the several branches of the Lea was, that in consequence of the increasing upland drainages, the floods had of late come down more suddenly and powerfully than had hitherto been the case, or than there was any reason, from past experience, to expect. On this ground the officers were acquitted.

What are the obstacles to the removal of the defective land drainage in the vicinity of populous districts?—The want of a proper and impartial authority to survey and determine what would be the best mode of treating the case: what expenses should be incurred, and what compensations should be given, and how the increased produce should be applied.

On a survey of Tottenham, what land do you consider would be the best for the application of the refuse as manure?—The marsh land, for that land is on a lower level than the village, and nearly all the sewage of the village runs to waste through it into the adjoining mill stream.

Mr. James Dean.

If this marsh were properly drained, and the land prepared for and properly irrigated, what do you conceive this same land might be made worth?—From 8*l.* to 12*l.* per acre, at the least, might be produced at an original outlay not exceeding 8*l.* or 12*l.* per acre.

And from what you have stated, are you confident that by the proper management of the irrigation and the application of the refuse in the liquid form, the soil being rendered permeable by thorough drainage, this application would be inoffensive and less injurious or objectionable than any top-dressing?—Certainly; there is much top-dressing with stable and other manure used on several thousand acres of grass land about Tottenham, which is not the subject of complaint; but for the reasons already stated the application of manure in a state of dilution would be far less offensive than dung spread in a solid form as top-dressing.

What would be the additional agricultural produce probably derivable from the improved application of the refuse of the village?—About 3000*l.* per annum would be the value of the increased produce.

What might be the probable value derivable from the practicable improvement of the uplands by their more speedy relief from the excess of water with which they are at times oppressed?—Of one thousand acres the improved value would, I have no doubt, be at least 10*s.* per acre; of another thousand, 5*s.* per acre; and of another thousand, 2*s.* 6*d.* per acre, making a total of nearly 1000*l.* per annum.

Would it not also give another contribution to the salubrity of the district, by increasing the dryness of the atmosphere?—Yes; for the soil of these uplands consists, for the most part, of a strong retentive clay. There is a great deal of rheumatism amongst the labouring classes in the upland portion of the district, whilst there is much fever in the lower portions, particularly those bordering on the adjacent marsh.

Are there any commonable lands amongst these uplands?—Not any.

Are there any commons or any other commonable lands than the marsh lands?—There are about 100 acres of commons and waste land.

Are they also undrained?—Yes, they are.

What is the description and value of their produce?—Whilst the Lammas lands are laid up for hay, the cattle are turned upon these commons, belonging to small occupiers, or to a description of persons having no land at all, called for that reason “sky farmers,” who poach the hedge banks and destroy the hedges by the road sides; each owner of the cattle being compelled to send a “tenter,” or some one to watch them, for otherwise the cattle would be sent to the manor pound. A number of boys and girls are thus collected together as “tenters,” and brought up in idle

and demoralized habits. The value of this land would not, in its present state, be estimated at more than 1s. an acre. Mr. James Dean

What would be the additional produce and value of this land if it were properly drained and cultivated?—The produce would not be of less value than 10*l.*, the rent not less than 3*l.*, and the expenditure for labour not less than 1*l.* 10*s.* per acre, the rest being for seed, interest on the farmer's capital and profit, poor-rates, tithes, &c.

You have stated that the commons, which in their present state are worth about 1*s.* per acre, would in their improved state, when enclosed, produce probably 30 times that amount to the labourer. What may be the value of the Lammas rights now exercised on the marsh to the commoners per acre per annum?—Nineteen out of twenty who have the rights derive no advantage whatever from them, and, if the amount were divided amongst them, it would be a mere nominal sum. To the twentieth portion of the commoners the right to the Lammas feed would be worth 3*s.*; but if the whole Lammas right belonged to one man, the feed would be worth about 10*s.* an acre, because he would stock the land in the most beneficial way, and would be freed from the inconveniences and injuries to which I have alluded.

You are aware that such Lammas rights are frequently found to stand in the way of the extension of towns and the relief of those overcrowded by new buildings, and consequently occasion the labouring classes in the interior of towns to be oppressively taxed for inferior tenements, and to be injured in their health by overcrowding?—That must frequently be the case.

Then, as a measure of improvement, the enclosure would be of great value to the labouring classes?—Undoubtedly.

But might not beneficial reservations be made and applied for the advantage of the town in lieu of the rights of common to those who are entitled to them?—I have thought, in our case, that 10 acres nearest to the parish church should be allotted to the labouring poor for gardens, to be vested in trustees; another 10 acres to be set out, drained and maintained in good order, for the recreation of the inhabitants generally; the remainder to be divided between the lord of the manor and the freeholders and copyholders.

The arrangement you have proposed is the one you deem the most beneficial to Tottenham; but are not the circumstances of different towns so various as to require investigation into and adjudication upon the various rights, privileges, and claims in each case?—Certainly such inquiries would be necessary.

Might not the claims to the intermittent exercise of rights ranging over the whole of what are called commonable lands, be beneficially commuted into a continuous right over a portion of the land; and might not the possessors of the right of common advantageously receive a pecuniary compensation, and the ancient

Mr. James Dean. right, now become unsuited to modern wants and usages, be extinguished?—Such a commutation would be one step in the right direction, and if vested in trustees with a power to make exchanges, would ultimately be very beneficial.

Is not the exercise of these rights commonly a source of continued bickering and contention, and of party and local agitation?—Generally so, and not unfrequently sources of litigation.

From what you have already stated, it appears that you are clearly of opinion that in the case of Tottenham, which appears to be a common case, that the house and street or town drainage, and the drainage of the water-courses of the contiguous land, the relief of the upland waters, and the drainage of the lower levels of the adjacent marsh lands and commons and wastes, are parts of one measure either for complete sanatory improvement or for the best agricultural production, in the vicinity of such towns?—Yes; no portion can be dealt with separately, even for complete improvement in itself. In this one measure must be included the dealing with the exercise of the rights of a water-mill, which stands in the way of every agricultural and sanatory improvement. This mill, by stopping up the water which comes down the river Lea, and the water from the river Moselle, does injury to the parish to the extent, I have no doubt, of at least 2000*l.* per annum. The case of this water-mill is so common a case, that I would urge it particularly on the attention of the Commissioners not only as affecting the sanatory condition of the population, but extensively the drainage and improvement of the land in the kingdom. In this particular case no water can be diverted for household purposes, or for cleansing of the town,—for irrigation or for farm-yard purposes; it shuts up the outfall to the drainage of the marsh land and much other land in the vicinity, and consequently it affects the value of the land and property almost of the whole parish. The extra expense which would be incurred by the mill-owner by the removal of the obstacle to these improvements would be little more than the expense of the erection of the steam power, which would answer as well or better. I speak with confidence on the subject of such right, because I have been frequently called upon to give evidence before courts of justice upon the subject of the powers which millers or the owners of water-mills possess over the water supplying their mills, and upon trespasses committed upon those waters. I could bring forward instances from every part of the country where I have been, of streams which should have a free flow, and should supply a town, tailed up from 10 to 20 feet producing a sluggish and stagnant flow; interfering not only with the whole of the drainage immediately adjacent to the town, but with the beneficial use of the water for irrigation and other purposes miles above and below it. The extent of mischief produced by the right of tailing up streams for mill purposes appears to me not to be sufficiently appreciated. A mode of procedure for the

purchase of such rights, and for compulsorily taking them on settled and liberal conditions, would be of the greatest importance for the improvement of the health of towns, as well as for the general improvement of agriculture. In the vale of Honiton, a mill, the rent of which was, I think, 22*l.* per annum, or not exceeding 30*l.*, I found standing in the way of the supply of a number of farmsteads and interfering with improvements ascertained to be of at least 1000*l.* per annum value. After having served those farmsteads, it might have been carried across the valley to a level capable of sweeping the whole of the sewers of Honiton; but the mill belonged to a tenant for life, who could not grant the requisite term to enable parties who would have advanced the necessary capital to carry the works into effect, beside which there would have been a difficulty in compelling payment of the rents, which an Act of Parliament alone could have enabled the adventurers to enforce. I scarcely know one town or village in England with which there is a stream connected, and upon which there is a mill, where similar evils are not maintained by tailing up the water. It is scarcely an exaggeration to say that, for every shilling of mill rent a hundred pounds' worth of injury is done to other property, setting aside all consideration as to the effect of a proper drainage on the public health. The pecuniary injury is not confined to the effects on the direct or main stream, but is extended over the whole of its tributary branches, often for miles distant. The extent of injury is rarely if ever traced. It is more commonly felt on attempts to drain lands, when it arises as an obstacle to the getting of a proper outfall. It also acts as an obstacle to beneficial irrigation. It has grievously interfered with my own operations for drainage, and must frequently interfere with any such operations on a large scale. It has happened to me in numerous instances, that when I had surveyed an estate and laid down a promising plan of drainage and land improvement, on looking for my outfall, I found that some one man below had got a portion of the water-course, filled with sedges and mud, which rendered the water stagnant and pestilential, over which portion, having no control, the whole plan has failed. At this time, from the improvement and increased cheapness of steam power, the value of mill-streams, except perhaps in the neighbourhood of some large manufacturing towns, is greatly reduced; and very favourable opportunities are presented for buying up these rights. In laying down plans for improving of estates, I certainly should not advise the erection of water-mills, but should propose steam-engines, which could be used at all times and for all purposes; because if there was a fall of water, it might for farm purposes be applied more beneficially than for mill power. Steam-mills are now beating water-mills, on account of the regularity and certainty with which the work is performed, and its greater cheapness in most situations. My experience leads

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Mr. James Dean. me to believe that half the water-mills in the country might be purchased at reduced prices. The instances given in the Sanatory Report of the injuries done to the health of towns in the north by mills which tail up the streams on which they are situate, are quite consistent with my own observations in the south and west of England.

Would it not be a means of facilitating such improvements if the repayment by the parties interested of principal and interest were spread over a period, say of thirty years, or any other equitable period?—Yes; I should say twenty years, because the redemption would, at the rate of 5 per cent., return the principal, with interest, within that period. No one could object to such a mode, as money might be borrowed for the purpose, by Exchequer Bills, at about 3 per cent. per annum, secured on the land.

Why have you chosen twenty years for the repayment rather than a more extended period?—Because twenty-one years is the usual period for tenants for life to grant leases under settlements or otherwise, and because twenty years is the time authorized by Gilbert's Act in which money borrowed for the improvement of glebe houses is to be repaid; and no inconvenience having arisen in practice from those limitations, I deem the precedent a good one.

With all the advantages derivable, pecuniary, sanatory, and moral, from the measures specified, if enabling powers were given to the population to adopt them, do you think they would be voluntarily adopted and carried out by agreement amongst the parties interested?—I have no doubt that any merely enabling powers would be carried out as the enabling powers under the Highway Act to cleanse the ditches and water courses are carried out in Tottenham,—that is, not carried out at all.

The enabling powers of any general improvement Act being in your opinion ineligible, would special powers under a local Act be eligible?—I have no hesitation in saying that as local Acts are at present initiated, and framed and passed, any remedy by such Acts is impossible. In the first place the expense of a private Act, even where there are no persons to get up opposition, would be from 400*l.* to 600*l.*, which would defray much of the expense of the necessary drainage. The parties enjoying common rights are so numerous that it would be impossible to get the consents required by the House for its security. At the best and in the cases of the larger works, where the legal expenses are not so disproportionate as it would be in the case of commons and patches of land near towns, the mode of proceeding by local Acts is extremely unsatisfactory, where private rights and conflicting claims are involved. No one but those who have a strong purse can pay the expense of opposition. The poor and private individuals, who have small, but to them very important rights, have no means of getting up to town, and appearing to defend themselves against

unfairness or oppression. The instructions for drawing such Bills are commonly given by tradesmen or persons in parish office, and the Bills themselves are frequently drawn by persons who never before perhaps prepared any similar measures. And it has been observed, that Parliament in giving such powers to remedy local evils acts like a physician, who never sees the patient but gives one prescription on the hearsay of ignorant or interested persons, and never after attends to the case to see what will be the course of the disease, and alter the prescription accordingly. What I apprehend is wanted is the intervention of a competent authority to examine into each case, and determine on the measures applicable to it, and most of all the claims to compensation, and the equitable distribution of charges. Mr. James Dean.

Then you concur in the suggestions that in whatsoever mode new powers or local privileges are conferred, such grants ought always to be preceded by examinations on the spot by some competent authority?—Yes, I do, and that such an examination is necessary to protect Parliament itself, or the Crown, from granting oppressive powers or privileges for the execution of very expensive and imperfect works. It is, I also concur, necessary to check the spirit of jobbing which, I am sorry to say, is but too prevalent when local improvements are in hand. If there had been such independent surveys, and an examination in all cases of new railways, not only would the shareholders have been saved much expensive blundering, and a good deal of plundering, but the land would in all probability have been protected against the damage done by the frequent erection of barriers against future drainage, which might have been provided for.

It has been suggested that such plan (founded on the improved survey) prepared or examined on the spot by a competent officer, should in all cases be accompanied by a justificatory report, expounding the local evils proved to exist, and the proposed means of meeting them,—the benefits which appeared to be attainable,—the expenses to be incurred, and how levied,—and the proposed application of the proceeds and schedules of the claims to compensation,—and of the proposed allotments should be printed in a cheap and popular form, and circulated within the district for the public information,—and to give parties interested fair time to submit objections either to the plan of the works or to the claims for compensation proposed for adjudication: what is your own opinion on these proposals?—It is entirely in concurrence with them. We must remember that almost all persons within any town or place who act as movers in any public measure have their own private personal interests, or will be believed to have them: if they are owners they are distrusted by occupiers, and all are employers of labour, and are viewed by the labourers as persons having interests opposed to them. However pure the suggestions may be, they are distrusted by their fellow townsmen.

Mr. James Dean. The general expression is, "Why should they be for doing this unless they are to get something for themselves." And I beg leave to repeat that too commonly local improvements are moved only as jobs, and the people have been frequently taken in by misrepresentation respecting such works, and they really have some justification for the distrust. On this account they would be much more likely to have confidence in some independent public officer, who might be, and should be made really responsible, and not in character merely, for what he states. Such an expository report would be of peculiar advantage, and would indeed be necessary in the case of the enclosure of commons, because the first aspect of that measure is always one of taking something from the labouring classes, and it is just to give them the assurance that it would not have been done without it was right and good for themselves as well as for others. I agree also that enclosures near towns should not be proceeded with solely for the increased profit from increased production. The sanitary considerations, the drainage of the waste, the reservation of public gardens, walks, and well-kept play-grounds, allotments for improved cottage residences with gardens attached, and for the extension of the town, will generally be found to be even of greater importance than the increase of produce. The local examination, if proper care were taken, would also enable parties to obtain hearings who never would think of seeking a hearing before any Parliamentary Committee. On this account it seems the more necessary that these proceedings should as far as possible be conducted under some judicial control by a known and responsible public officer, who may at any time, or in any stage of the proceedings, after the plan has been sanctioned, be written to that any unforeseen inconvenience may be obviated, or oppression be at once prevented.

Supposing an adequate survey already made, and the contour lines, marking equal or parallel altitudes, were plotted, in how long a time and at what expense might a competent civil engineer devise and lay down a general working plan for the better relief of the uplands; the direction of the water to the cleansing of the village (or town) of Tottenham, which you have given as an example; the drainage of the adjacent marsh and the application of the refuse of the town to production in the manner you have pointed out, that is to say, such a complete measure as, when executed, would serve to drain, cleanse, and put the whole inhabited area in what may be deemed a good sanitary condition? —I believe that a competent civil engineer might lay down an efficient working plan in a month, at an expense of about 100*l.*; but if he were a public officer, devoted specially to the work, it might be done in almost half the time and perhaps for half the expense.

What is the area of the village or town of Tottenham, and of

the adjacent district, including the uplands and the contiguous marsh?—The area occupied by houses I should think is about 500 acres; the uplands and the marsh will make the whole area about 4500 acres. The present adopted scale of the Ordnance survey for towns is 60 inches to the mile, and includes a series of levels displayed by contour lines at every two or four feet, to facilitate the house and street, the branch and main drainage of the towns, and levels for the regulation of new buildings and drainage of the suburbs.

Mr. James Dean.

Would not surveys at such a scale answer all drainage and other purposes of agricultural improvement for the lands in the suburbs or adjacent, as well as for all measures of towns' improvement?—A survey on such a scale, if accurately executed, would be of the greatest advantage, not only for sanatory improvement in towns but for all land drainage, for irrigation, and for all agricultural improvement. It would, besides, facilitate the laying out and drainage of reservations of waste lands, as gardens and public walks, the enclosures, and drainage of the commons, and their improvement and beneficial application either for improved buildings, of cottage tenements with garden allotments, or the drainage and better cultivation of any portions of them that might be let for agricultural production, as might be determined after a proper examination in each locality. I think it very important that such a survey should not be restricted to the town, or what is usually understood by the suburb, but should comprehend as much as possible of the agricultural district immediately connected with the town. In our district, I think, such a survey should not only include the area of 4000 acres which I have mentioned, but, at least, the whole district known as the Edmonton Union.

The expense of surveying, plotting, and drawing, levelling and laying down contour altitudes without as well as within the towns, the laying down sewers, water and gas-pipes, and marking each house, is estimated at 3*s.* 8*d.* per acre for a town of 10,000 inhabitants; the expense, therefore, for the town of such a size as Tottenham, which you estimate at 500 acres, would not exceed 90*l.*; they might also be engraved at a low additional expense, and copies sold for private use?—[*The engraved plans on sale of the Ordnance survey of the city of Dublin were here shown to the Witness.*]—Whether for town or for the rural districts the expense would be inconsiderable, and not worth naming as compared with the advantages derivable from such work.

Would not a survey on the scale described be of great advantage in giving the levels?—Presuming that, in such a work, the levels were taken with perfect accuracy, it would be of very great advantage. But the subsequent engineer's survey and report as to the means of cleansing, deepening, widening, and straightening

Mr. James Dean. the courses of the living or running waters, the common water-courses, would be of the greatest advantage. If the outlets which come within the jurisdiction of the surveyors of the highways in our district were properly opened, I believe it would reduce the expense of the private land drainage by one-half; and the same may be said of all other districts. But, to do that effectually, the law must be made compulsory on those officers to scour, cleanse, deepen, widen, and, if necessary, straighten all such outlets.

You have given great emphasis to the necessity of thorough and effectual drainage as essential to a perfect irrigation: is it to be inferred that you consider that errors in respect to the mode of drainage as well as to the scientific management of irrigation are common?—I do not hesitate to declare, that of the private land drainage now carried on by owners or occupiers, not one piece of work in ten is complete or perfect.

You are aware of the great expense incurred for private land drainage, and the great attention given to the subject, and do you give this opinion of these works deliberately?—Yes, I certainly do.

What, in respect to the land drainage, do you find to be the common defects?—Irregularities in the bottom of the drain; bad falls (which is to be understood of flat lands which stand most in need of drainage); and insufficient outfalls: hence the drains are soon filled, and choked with the deposit of soluble matter, rendering the drains inoperative. Then there is a statement—“We have been at great expense, and the drainage has not answered.” In ninety cases out of a hundred where this has happened it has been from want of skill. If there be an irregularity amounting to two inches, and the tile-drain should be three inches in diameter, it is evident there will be but one inch for the flow of water; with an irregularity of three inches, which the most practised eye would be unable to detect, there would be no flow at all. But if common workmen were taught the use of boning-rods, using also the common mason’s level, it is impossible that the evil complained of, either in respect to land or houses, could occur.

Independently of the advantages of increased production, it has been agreed that there is a special public interest in the private land drainage in the vicinity of towns in respect to the health of the population, by the avoidance of the damps and fogs that arise from undrained land. Besides the general facilities for private land drainage which may be afforded by a survey with levels, adapted to all public drainage operations, or such facilities arising from better measures for the clearance of water-courses, or what may be termed the highways for the free passage and clearance of the living waters, which you say would greatly reduce the expense of private drainage, are there any other and what facilities

which you think might be given for such drainage by any legislative measures?——One of the most important facilities to the private land drainage would be to constitute an authority to remove obstructions to the free flow of water from undrained lands distant from any main outfall. Such an authority might be vested (subject to an appeal to a proper authority in London) in any properly qualified engineer, surveyor, or other officer having charge of the public drainage, supplies of water, or public works for the cleansing and application of the refuse of the next town district. Farmers, unless they are very particular friends, and then they usually do it doubtingly and grudgingly, rarely accommodate each other in these respects. Proprietors rarely lend any aid to works of this kind. The right to the free flow of the water is very little understood. The first question put upon such an application is, “I do not see why I should do this; I don’t see what may be the end of this, or what right I may be conferring.” The intervention of a public officer under a central authority, who had no rival interest, and whose opinion would not be suspected, would remove many obstructions, particularly by allaying the suspicion that some undue advantage was being given. Improvements as to rights of the law of water-courses, and the giving a summary and accessible remedy for infractions of them, would tend greatly to the complete drainage of the land, which is of so much consequence as a measure of sanatory improvement in town districts.

Mr. James Dean.

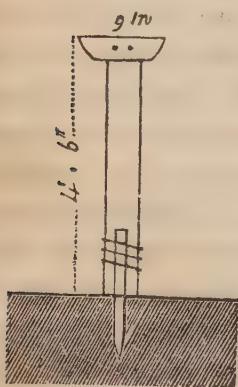
Have you considered of the application of the house refuse and of the sewage of the metropolis to agricultural production?——Yes, I have. I have, with the assistance of my son Arthur, prepared plans and sections, which I now produce, for the saving and application of a large portion of it, especially of that derivable from Bethnal-green, Whitechapel, and Spitalfields, and beg to refer to the plan made by us, which shows the direction of the proposed sewerage and drainage, and also the proposed site of the settling ponds or reservoir; the fall for the sewerage from the General Post-office to the Trinity low water-mark at Woolwich being 54 feet, and the distance about 7 miles.

Will you describe the plan you proposed for the purpose?——I propose to form a sewer, at a lower level than the sewers now in use, so as to command the sewerage of the parts of London north and east of Whitechapel-road, Leadenhall-street, Cornhill, Cheapside, Newgate-street, Holborn, and Oxford-street: the main sewer to be carried in the direction of the terminus of the Eastern Counties and the Northern and Eastern Railways in Shoreditch; thence in the direction of the Victoria Park, now in progress, under a line of streets passing through Bethnal-green and through the Victoria Park to Old Ford, and thence in the direction of the stations of the said railways at Stratford. From that point I propose to carry the sewage into the marshes northward of West Ham and Plaistow, and thence to the river Thames below Woolwich: thus con-

Mr. James Dean. veying the soil and water of the sewers to a point where the contamination of the water of the Thames would be much less felt than at present, and much that is now offensive and injurious to the inhabitants of London would be got rid of in that way.

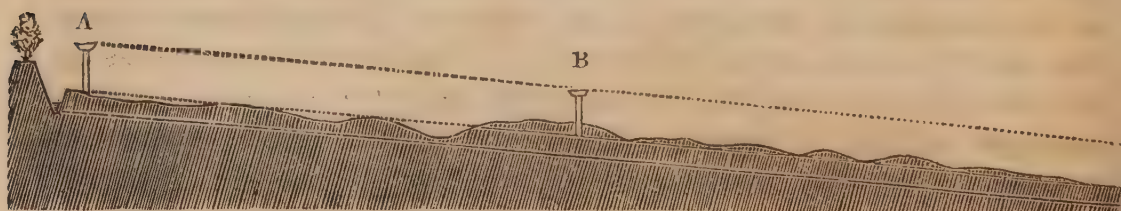
Having brought the sewerage of the district you have described to this point, what mode do you propose for its application to agricultural production?—I propose to form a series of filtering ponds, say twelve in number, of six acres and a half each. Into the first of these the whole of the soil and water would first pass, and when filled the valve to be closed and the sewage carried on to the next pond, leaving the first to settle, and so on through the series. When the soil has sufficiently settled, I propose that the water shall be drawn from the settling ponds into contiguous reservoirs, where it might further settle until the water should be reduced to nearly a limpid state. When in this state, charged with ammonia, I propose that it shall be let out into irrigating feeders, and thence be distributed over the marshes below, of which there are several thousand acres. The solid portions so deposited I propose for sale, and, being the best description of manure, would always be in demand. I propose that it shall be barrowed from the bottom of the settling ponds into barges or other craft floating in a canal between the settling ponds, and from thence be conveyed through a tidal lock into the Thames for conveyance in the direction of demand.

Fig. 1.



Will you, for the information of non-professional persons, describe shortly the mode of using boning sticks?—I will here describe the boning rods. They are rods made of deal, 2 inches wide, clean and straight grained. These rods have a stake each, made of inch square oak, 2 feet long, pointed at one end to drive into the ground. To these the rod, which is 4 feet 6 long, should be tied. At the top of the rod there is a cross piece, 9 inches long and 3 inches wide. (See fig. 1.) One side of this cross piece is painted white and the other side black, that they may be seen the better in different atmospheres. The whole is of the form shown in the annexed sketch, with a rod tied to the stake, which is fixed in the ground. Any village wheelwright or carpenter may make these rods without difficulty, and at a few shillings expense. There is rarely occasion for more than three of these rods; never for more than four.

Fig. 2.



Patterns of these rods and builders' levels may be seen, or sets Mr. James Dean. obtained for 30s. at Mr. Mannings, builder to the Royal Agricultural Society, 251, High Holborn. Being provided with a set of these rods, we will suppose a piece of ground of irregular surface to be drained. The first thing to be ascertained is which is the highest and which is the lowest point at the extremities of the piece of land to be drained. On this piece there will be irregularities in the surface either natural or from repeated ploughings, some portions of the surface being higher and some lower than the extreme points. At the highest point A, drive down one of the oak stakes a few inches into the ground. To that tie one of the boning rods, letting the bottom of the stick rest upon the surface of the ground, placing the cross piece at the top at a right angle with the line of direction to the lowest point C. Then proceed to do the same with another boning stick at C. The workman will then proceed with his spade to a point, as near as may be midway between the rods so fixed. The surveyor will take a sight from one boning rod to the other, and will, by a movement of the hand, direct the labourer until the two boning rods and the handle of his spade set upright are in a line. Having got them in a line, the labourer makes a mark by turning up a little of the soil with his spade. At that point he then places one of the boning rods, holding it at arm's length and standing on one side, so that his body may not interfere with the line of the sight which the surveyor then takes. If the spot on which this third boning rod is now held up happen to be an elevated one, ascertained by the surveyor taking a sight from the boning rod at A to the boning rod at C, and the elevation of the cross piece of the boning rod at B is judged to be about nine inches above the line, the labourer will be directed to lay down the boning rod, and with his spade dig a hole from a foot to 18 inches square, about two spades wide either way, and of the depth which he will judge to be of about nine inches. Having cleared the bottom of the hole of the fragments of earth, he will again hold up the boning rod, resting it upon the bottom of the hole. The surveyor then takes a sight to see whether the cross pieces are exactly in a line. If they are not so, if the centre rod is too high, the labourer is directed to take out earth, if too low to put in earth and press it down, and this work of adjustment goes on until the three cross pieces are brought exactly in a line. The labourer then drives down one of the oak stakes, and ties the boning rod to it. Then the fourth stick is used between the middle one and either end one, and the labourer proceeds with his shovel to find out the middle between A and B, or C and B (as before). We will now suppose that there is a hollow of nine inches. The same process goes on between the labourer and the surveyor, as in the last case, but the labourer, instead of digging out, adds or raises with his spade nine inches of soil, making it firm, by beating with his spade upon the

Mr. James Dean. top; and upon the surface so raised, he drives one of the oak stakes, and ties one of the boning rods, when adjusted by a sight taken by the surveyor to be in an exact line with the three previously fixed. These rods being fixed, the next point for the surveyor to determine, is what shall be the depth of his drain below the general surface. If the surface be irregular, the first point of care is, that the bottom of the drain be not brought too near the surface at any point of the line; not nearer, we will say, at this point than 18 inches. The leading point now is to ascertain what is the greatest depth that the drain can be placed at the outfall. Assuming that to be three feet, it follows that the depth of the drain at the highest point should not be less than two feet below the surface. The lower bottom line will show the line at the bottom of the proposed drain. The intermediate line shows the general surface of the ground, which is two feet above it. The workman then proceeds to dig out for the drain to the depth of the lowest line. He digs two holes, one at A, two feet, and one at C, three feet deep below the surface of the ground. He then lengthens out with another piece of deal each of his boning rods two feet. He then drives down into the bottom of the two holes the same stakes that were used in levelling the surface, and ties to the stakes as before the boning rods so lengthened out to two feet. He will then proceed to dig out the drain, using the other boning sticks lengthened out to two feet, in like manner as the two already fixed; taking care not to get below the run of the line of the bottom of the drain. When by repeated application of the moveable boning rods, the bottom of the drain has been made to agree throughout with the tops of the boning rods that are fixed, it then becomes the important duty of the surveyor,—going through the same process in respect to the bottom of the drain as was gone through in the first instance with the surface of the land, to verify the work before a tile, or tube, or stone, or any other material is filled in. Being thus verified, the work is completed.

Have you instructed common workmen to perform this process?—I have. After the first job of a few poles is completed, an ordinary good labourer will go through the whole process as well as any surveyor. The determination of the position of the drains and the number of them will belong, of course, to a higher order of information; or to the class now known as agricultural engineers. Ordinary good labourers will, when instructed, do the boning work without an error of a quarter of an inch upon thousands of yards in length.

The process of boning, as you have described it, may be stated as being a process for making a straight line in the earth from two given points, or, practically, for ensuring a straight bottom to any drain with any run. Where the outfall is not visible to the eye, as where it may be necessary to carry a drain round a hill, or through a winding street, then, of course, the use of the spirit

level, or of the mason's level, will be requisite to find the outfall which cannot be seen, and when once these points are found, the boning sticks may be used as described?——Certainly; good workmen are easily taught the use of the mason's level, and if they are more extensively taught, the frequent failure of very expensive works of town drainage might be avoided. It is important for drainage that common workmen should be taught the simple use of a very common instrument, such as the mason's level, which is too often put out of order, and expensive service, which too frequently prevents these improvements being made, be rendered unnecessary.

VI.

ON THE IMPORTANCE OF GENERAL PLANS AND SURVEYS OF
TOWNS FOR THE PURPOSES OF SEWERAGE AND DRAINAGE
AND THE DISPOSITION OF STREETS AND BUILDINGS

CAPT. VETCH, R.E., examined.

Capt. Vetch, R.E. ARE you an engineer?——I am.

Have you given your attention to the practicable improvements, drainage, and other works necessary for the improvement of the health of towns, and have you been consulted as to the best mode of improving drainage and sewerage of Leeds and Windsor?——I was called upon by the town council of Leeds to examine into the condition of the town, as to drainage, sewerage, &c., &c., and to report on the best means of improvement, and I had the honour of being associated with Sir Henry De la Beche on similar requirements for Windsor and vicinity. I have now the honour to lay a printed copy of my report on Leeds before the Commission.

The Commissioners are desirous of being informed by you what scale and description of survey you consider from practical experience to be the most eligible for house and street drainage, and sewerage, and for the regulation of new buildings, or for other public purposes to which a comprehensive survey would be applicable?——The best and most appropriate scale for the several purposes required, I consider to be 88 feet to one inch, or one mile to 60 inches, this will be adequate to show the position of the sewers, water-pipes, and gas-pipes, and would serve the purpose of valuation, and of setting out improvements. The valuation map of Leeds was constructed upon a scale of 198 feet to an inch, but it proved too small for several purposes, and was afterwards, at some expense, enlarged to a scale of 99 feet to an inch, or double the original size, but the effect of plotting to a smaller scale, and enlarging afterwards, has the effect of magnifying any inaccuracies, whereas if the plan be plotted in the first instance to a large scale, and afterwards reduced, any little inaccuracy will be diminished, or disappear. The Ordnance plans of Dublin and Windsor, are on a scale of 88 feet to one inch, and the advantage of that scale for LARGE TOWNS, have become very apparent to me. To the plan of the site of the town, I would propose to add the *cropping out lines* of the different strata, as it appears to me important to mark the soils which are retentive or absorbent, as clay and gravel; I would propose on the plan to trace the water-shed lines, and also the contour lines, or lines of equal altitudes, say at every three or four feet of elevation.

Plan of Part of WINDSOR & PARK, to illustrate the principle of Contour Lines. Surveyed and Drawn for HER MAJESTY'S COMMISSIONERS OF Woods and Forests, by a party of Royal Sappers and Miners under the direction of CAPTAIN H. TUCKER, R.E. to accompany the Report of SIR HENRY DELA REUCHE & CAPTAIN VETCH, on the Drainage and Sewage of Windsor and its Vicinity.

Scale 60 Inches to 1 Mile



The Datum of Altitude is a Point 20 Feet below the Flood Mark "T" or "D" 1841 on the West face of the South Abutment of Windsor Bridge.

The distance of the Contour Lines from the highest point where Datum.

The points on the Contour Lines show the descending side.

Bachelor's Acre

Site of Old Mews

Grand Gate way

South

Drawn by J. H. Tucker, R.E.

Will you describe more particularly for the information of non-Capt. Vetch, R.E. professional men, the uses of contour lines on surveys?—The ground plan of a town shows the exact dimensions and relative distances of spaces, but it gives no knowledge of their absolute heights above a fixed common point or datum, or the relative height between any two sites, on the plan, but when the horizontal plan exhibits these contour lines drawn, say at every four feet and marked 0, 4, 8, 12, 16, feet, &c., we see at one glance all the places situated at these respective elevations above datum, and know their relative heights to each other, and with a little practice, the eye will be able to intercalate (within one foot or less) the intermediate heights between the contour lines; and to facilitate this operation, vertical distances of four feet between the contour lines, will prove most advantageous, as most readily admitting of subdividing. The contour lines on the Ordnance plan of Windsor are drawn at every 4 feet of altitude, and on the low flat ground subject to inundation at every 2 feet.

The engineer, or other person who therefore consults such a map for practical purposes, obtains a correct notion of the height of every part, on the plan, and the declivities or slopes; and for engineering purposes, a knowledge of the heights is equally necessary with a knowledge of the distances, and if the plans do not afford him that information, he must commence a number of levellings to show what is practicable, and what is not; these levellings occupy much time, expense, and delay in making, and at last only give the engineer the means of judging between the two or three or more lines which he has levelled, while the contour lines enable him to judge of every possible line he may wish to examine or compare.

By means of contour lines, in any street, or lane or building site, the direction of the fall of the ground is known at sight; and the amount of that fall, in proportion to the distance, may be ascertained between any two points situated on the contour lines; thus the fall from *a* to *b* on the diagram, is known by the contour lines to be eight feet; and the distance measured on the plan being 400 feet, the slope would be one foot in 50. An engineer can therefore see, without any trial levels, the undulations and descent of each street from one contour line to another, and he knows the amount of cutting or filling, to reduce the street to a level or a regular incline. He knows also what descent the kennels and sewers may have, and how they must join each other, without wasting time and money on a number of trial levels. If the town is situated on the banks of a river, and if the floods of the river rise, say four feet above datum, he will perceive at once the extent of such floods, as shown by the tinted ground on the diagram, enclosed within the contour lines marked with the number (4) or 4 feet, and the engineer then knows over what extent to provide for such floods in laying out roads, streets, or drains, &c.

Capt. Vetch, R. E.

If new streets are to be laid out, the engineer will perceive at once, from such a plan, the declivity and aspect of the building ground, and the best line of drainage adapted for them.

The contour lines being drawn on the map, and identified by corresponding marks on the buildings, serve as a record and reference for all past and future purposes. It is true that if no contour plan exists, the engineer may get what he wants by having recourse to extensive levellings for each particular object; but this expense is generally lost for any future object, or for any other occasion, and thus the same trouble and expense may have to be incurred frequently for levelling the same piece of ground; but having the whole extent of the town and district before him on a contour plan, the engineer can study his subject to better advantage, and observe how improvements can be best and most economically effected. In waiting for trials of level, time is lost, and the engineer is always loath to employ more time and money on these than can be helped, and he concludes without having the case sufficiently before him.

When levels are executed piecemeal, and at various times, each engineer selects his own datum, and confusion and mistakes are thence likely to occur, so that no cautious engineer would trust to any previous work, but would level up to some fixed point, however distant; but even if otherwise, he might not choose to risk his reputation to the previous levellings of others, of whose qualification he could not judge. But if the levels or contours were executed by the Ordnance survey, his confidence would be complete.

If contour plans and marks were made under the authority of Government, the facilities and economy afforded by such a previous work would be manifest, and cannot be too highly appreciated both for the saving of time and money, and for insuring accurate judgment and execution in the works of improvement, and I have no doubt that were such going forward to any extent, the expense of the Ordnance levels and contours would be saved in three years, in the mere employment of surveyors, independent of the errors and expenses that might be entailed by less general and accurate views of the field to be operated on; but having served for any particular purpose and occasions, the Ordnance contours and levels would be ready for use again and again, and one datum would be established, to which all altitudes would be referred. For the purpose of applying the liquid manure to irrigation, the contour lines would be essential; and at Leeds they would prove particularly serviceable for that purpose, and also for the extension of the buildings, and for the drainage on the low flat part of the town south of the river.

By referring to the diagram plan already noticed, the advantages of contour lines will be more readily perceived. The contour lines are there drawn at every four feet of altitude, above a fixed datum,

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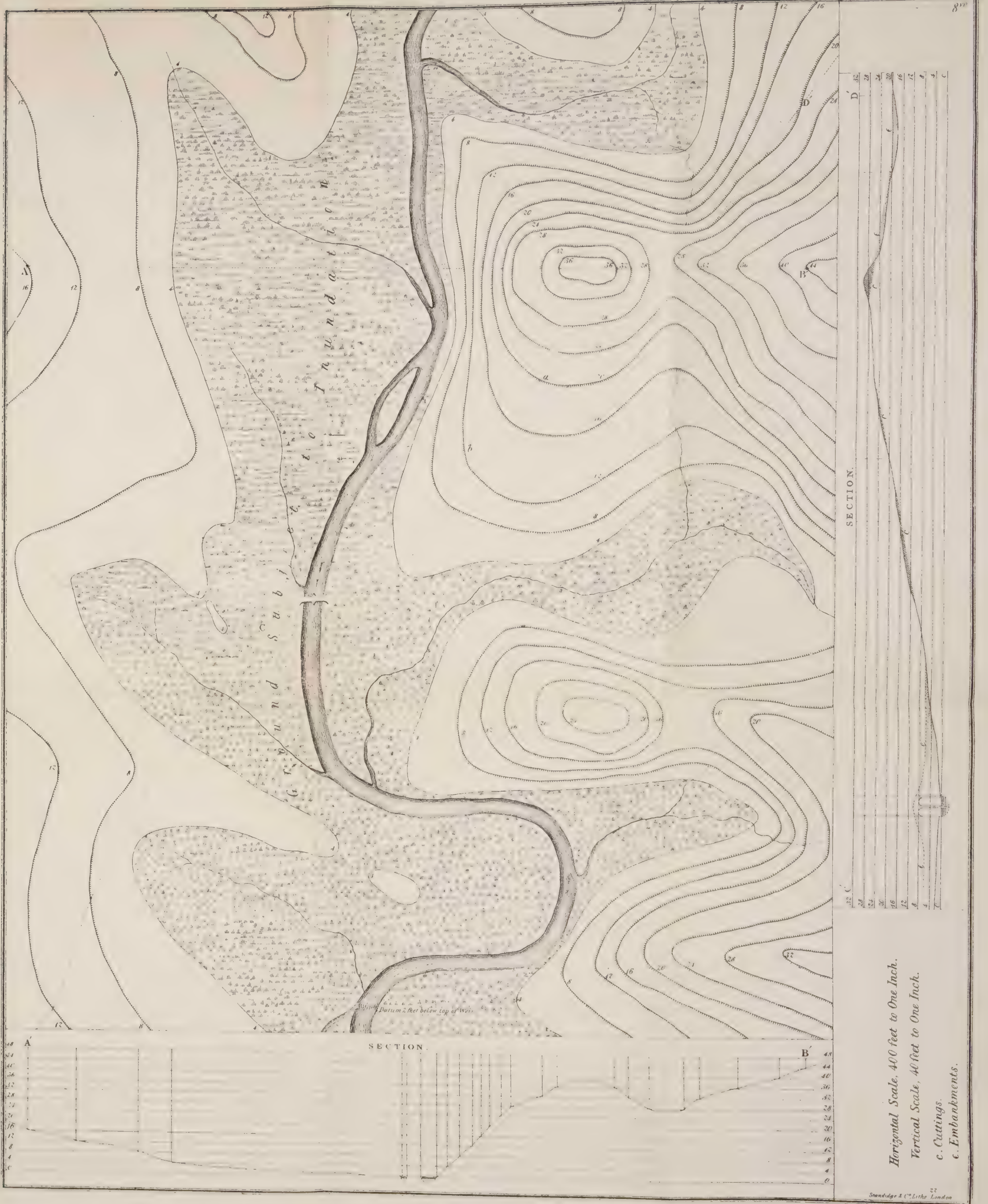


DIAGRAM TO ILLUSTRATE CAPTAIN VETCH'S EVIDENCE ON THE UTILITY OF CONTOUR LINES ON PLANS.

and have a slight etching on their under side, the more readily to point out the direction of the fall of the ground, and this in some cases is essential, as otherwise it would be difficult to distinguish at sight between an isolated hill and isolated hollow. Capt. Vetch, R.E.

From such a contour plan a section may be procured in any direction in a few minutes; suppose a section is required of the ground between the points A and B, we have merely to draw the line A B on the plan, and a corresponding line A' B' on section, and under the last to draw a number of parallel lines at equi-distances of four feet, to whatever vertical scale we think most appropriate; on the diagram plan the scale is 400 feet to an inch, and the horizontal scale on the section is the same, but the vertical scale, to render the subject more distinct, is 40 feet to one inch. The next operation is to apply the straight edge of a slip of paper on the line A B (on the plan) and to mark off on the first all the intersections of contour and other lines; this done, the slip of paper is next applied to the section lines A' B', to which the marks of intersection are transferred, and from these marks so transferred, perpendicular lines are drawn to the line A' B', and the intersection of these last with the parallel lines of the section already drawn as mentioned above, give the various heights on the section, and nothing further is required than to join these points with lines, to give the outline or profile of the ground, and all this may be done a hundred miles from the spot; but if no such contour map existed, the engineer would have to send a surveyor with instruments to level over the ground, and considerable delay and expense must be incurred.

Again, suppose that it is wanted to lay down a new line of road from C to D, without recourse to a section, the contour lines would show that the dotted line C D would be very direct, and would give the most gentle ascents and descents, and if it be required to know the amount of these, and the quantity of cutting and filling to reduce the line of road to a regular surface, and above the influence of floods, we have only to repeat, in regard to a section on the line C D, what has been said in respect to that on the line A B, from which will be shown the cuttings and embankments necessary for our purpose; the spaces between the dotted line, and the line of surface indicating the extent of each.

If the contour lines on a plan give such facilities for laying out common roads, these advantages will be still greater in respect to laying out railways, canals, embankments, and water-conduits.

What do you consider would be the expense of laying down these contour lines?—In conjunction (or rather prior in order) to the contouring, levellings will have to be made to determine with great accuracy the positive heights of a number of points within the town, as has been done by the Ordnance survey in several towns, and while that process is going on, the contour lines can be added at little additional expense. Thus at Leeds, over a

Capt. Vetch, R.E. space containing about 120,000 inhabitants, it was estimated that 80 miles of levellings would be required to establish a sufficient number of permanent bench marks in the town, and it was further estimated that these 80 miles of levelling would cost 200*l.* and the addition of the contour lines 50*l.*, and reckoning the number of houses at 26,666 the expense would be 2¼*d.* per house.

Do you concur in the opinion expressed by other professional persons, that where such surveys as you have described do not actually exist, that it is indispensable they should be formed?—It would be of great advantage, and indispensable to a perfect or complete treatment of the subject.

Does the drainage of Leeds present any peculiar difficulty to an engineer?—The town of Leeds, on the north side of the river, is by nature favourably situated for drainage. The river Aire forms the natural main drain of the site of the town, and would, if it had been allowed to remain in its natural state, have carried off all the discharges of filth by a pretty strong and regular current, but it has been intercepted by a succession of dams for mill power and navigation purposes; which form a series of catch pits for the manure of its 120,000 inhabitants. This filth is only partially removed by floods and dredging. I had occasion to observe, that the matter which had been dredged by the Canal Company from the river, consisted in a material degree of manure from the bed of the river, and the smell was highly offensive. I was informed that the Addle Beck which performs the duty of a sewer in its passage through the town was always most offensive on Sunday when the mill-water was let off, which tore up the deposits of filth from the bed of the brook. The river is also liable to be flooded, and on those occasions, this foul water finds its way into some of the houses through the sewers and drains. The little streams passing into the river Aire, and which now act as main sewers, having had their outlets elevated proportionately to the height of the dams, are thereby prevented from discharging so freely as before, and they are also more easily flooded, and the houses on their banks inundated; and it would, therefore, seem a wise provision in future cases before giving a navigation company control over a river passing through a town, to compel it to provide main sewers along the margin of the river.

Are the sewers and drains you observed well adapted to carry off readily the refuse water and filth?—On the south side of the town the drains and sewers being tortuous, lose much of their current and descent, and serve little to carry off the filth, and keep dry so large a tract of land, neither are they made with that attention to proper principles which the knowledge and science of the day would lead us to expect in such a town as Leeds. The following is a description from my report, of the state in which I found a sewer made only three years ago (pp. 3 and 4 Report, east of Marsh-lane.)

“Having learnt that the present sewer in Marsh-lane had only been laid down about three years ago, I was desirous, if possible, to avoid the expense of the construction of a new sewer, if the present one should be found equal to what was required; and to judge of its condition, I had it opened in five places, over a distance of about five hundred yards, and found it as follows:—depth, three feet; width, two feet; though towards the mouth of Timble bridge these dimensions are somewhat increased; the bottom and top of the sewer are flat, being formed with flag-stones; the side walls are perpendicular, and formed of dry rubble work, very coarsely put up, and admitting the leakage of the liquid filth of the drain wherever the adjacent soil is porous, and in all places constituting a harbourage for rats. Capt. Vetch, R.E.

“The sewer is conducted along the west side of Marsh-lane, near the gutter. At the first opening, the silt, or mud, was four inches deep; at the second, fifteen inches; at the third, eleven inches; at the fourth and fifth, very little deposit was observed; and my opinion is, that the size of the Marsh-lane sewer is hardly sufficient, that the flat bottom and want of a regular fall is the great cause of the depositions, to which the rough side walls contribute, and that the open structure of these walls, permitting the oozing out of the liquid filth is quite inadmissible, and that a new sewer is indispensable. As at one of the points where an opening was made, fifteen inches of silt was observed, it is safe to conclude that where the deposits is deepest, it may amount to eighteen inches, or one-half the whole depth of the drain, so that the time has already arrived when the sewer has to be cleaned out by hand, as I know of no other mode under actual conditions; but if such an operation is to be repeated every three years, it may even be found advantageous, in point of economy, to have a new structure executed.

“I have inspected all the streets in *the particular district* in question*, and most of the courts, and have found the greater part in a very filthy condition, most without any sewerage, many without pavement, and few with back yards or privies, so that most of the filth is thrown into the middle of the streets, where it remains.”

The following extract will show my opinion of the difficulty which at present exists of draining some portions of the town, and which is daily increasing. (Page 9, Report):—

“New streets and new roads are rising as mounds across the low grounds in many directions, and without respect to a general system of drainage, some localities seem as if destined to be cut off from the possibility of obtaining a good outlet; as, for instance, Bowman-lane and Chadwick-court, a locality which is low and wet, and subject to disease in consequence.

“It is to be regretted that, on so great an extent of low ground destined so soon to be covered with population, some general plan of new streets should not be adopted, in conformity with a good drainage and ventilation.

“Up to this moment the means of a good drainage still exists, but how soon such a measure may be defeated by buildings, I cannot venture to say; but I would strongly recommend that no time be lost in cutting the main and secondary drains, and of endeavouring to have the streets

* Viz., that east of Marsh-lane.

Capt. Vetch, R.E. constructed in conformity to them as a means of health and convenience to the whole population, and of increased value to the proprietors from a combined plan of buildings, which would render all the communications and conveniences so much greater."

Have you given your attention to the application of the sewage and refuse of towns to productive use for agricultural purposes by irrigation or other measures?—I have.

What arrangement did you propose for Leeds?—From the artificial condition of the bed of the river, as already described, and from the weirs and floods impeding the discharge of sewers into the river, but also from a wish to preserve the sewage for agricultural purposes, I designed two main drains, one on each side of the river, to collect all the interior drainage, and convey it safely to a distance below the town, and intercepting, as far as possible, any discharge into the river. These main sewers were so contrived, that while they permitted all surplus and flood waters to be discharged into the river considerably below the town, the means were presented of depositing the solid or sedimentary matter in covered catch-pits, while the liquid which flowed off, with manure in solution, was to be lifted by an engine, and applied to the purposes of irrigation.

What was the estimated expense of the main sewers of Leeds as requisite for collecting all the interior drainage of the town, and conveying it to safe distance in the country?—I estimated the cost of six miles of main sewer and two and a half of principal branch sewers at 22,639*l.*, exclusive of purchase of land and compensation for damage.

What do you consider would be the cost of applying the sewage of Leeds to the purpose of irrigation, and what produce do you expect from that measure?—The expense for the main sewers above named was necessary to the health, comfort, and cleanliness of the town, independent of any cost of applying the sewage to the land. On this last subject I have to state that the town of Leeds Proper, or that space which is pretty continuously and compactly built upon, and which includes parts of the townships of Leeds, Hunslet, and Holbeck, contains about 120,000 inhabitants, of which about 80,000 are located on the north side of the river, and about 40,000 on the south side, but the sewage of these two portions being entirely disconnected, it will be most satisfactory to estimate for the north side only, where it would be necessary to lift the water of the main sewer 50 feet by steam power in order to apply it to irrigation generally. The cost of steam-engine, tanks, pumps, &c., I estimate at 8000*l.* or under, and the annual expense at 550*l.*, and throwing these with contingencies into an annual charge, the amount would be 1000*l.* or under. On the other hand, assuming that I apply the sewage water from 80,000 inhabitants to 1000 acres of land, being at the rate of 80 to one acre, I am led to expect that after a lapse of some years for the due saturation

and enrichment of the soil, a produce to the additional value of 10% per acre would arise, from which, after deducting the annual charge, a clear benefit of 9000% would be derived on the 1000 acres; but as a proximate and general estimate I am inclined to consider the annual charge will prove about one-eighth of the net produce.

What time do you conceive must elapse before the land operated upon acquires the full value of the process?—Probably from five to seven years.

Have you taken into account the expense of preparing the land for irrigation?—Only to the amount of 2% per acre as a contingency; for I have considered that the ordinary manuring and dressing to keep the land in good heart being no longer required, the saving on that head would be equivalent to the cost of preparing the land for irrigation; this item would otherwise amount to about 20% per acre.

Did you consider that the borough of Leeds would derive a clear revenue of 9000% a-year from the sewage on the north side of the river?—Not so; I expect a clear benefit to that amount would arise from the measure; but it would be no easy matter for a municipal body to take the application of the sewage to the land under its own management. It might safely undertake to deliver it at a given point, and leave the further application to contractors; but it is not to be expected that the town would reap the entire benefit of the measure. The proprietors of the land most convenient for irrigation and the contractors must all participate.

Did you state these views in your report to the Town Council of Leeds?—I gave an outline of the mode of applying the sewage, and an opinion that at the end of 10 years the value might be safely estimated at 10,000% a-year.

Was a similar application of the sewage proposed for Windsor?—At Windsor, from the very small fall or inclination that could possibly be given to the main sewer, viz., 1 inch in 110 feet, it became necessary to compensate that defect by introducing a great volume of water (from the Thames above the town) to give the due velocity, which necessarily has the effect of diluting the manure of the sewers excessively, so that it is difficult to offer a decided opinion on the value of the sewage of Windsor previous to experiment; but I quite concur with Sir Henry De la Beche and others in considering that a very small quantity of fertilizing matter held in solution produces very powerful effects on vegetation, and consequently that the experiment (proposed by him at Windsor) would prove a successful one; and as the water would only require to be raised 10 or 12 feet, the expense would not be great of applying the principle at that locality.

Do you believe the same system is applicable *mutatis mutandis* to other towns?—I am persuaded that there are very few towns to which the system would not apply with advantage, and it appears

Capt. Vetch, R.E. to me to be one of those measures which science and observation have called so forcibly into notice as to render it almost imperative as a question of rational economy, and for increasing the productive powers of the country.

Have you had occasion to observe the different modes of irrigation in use for agricultural and horticultural purposes?—I have frequently seen the meadows on the east side of Edinburgh which are irrigated by sewer water, and am aware of their great fertility both from observation and from common report; and from the statements I have seen, I have been in the habit of estimating the rental at 20% per Scottish acre, say 15% per English acre, and of presuming that similar applications in this country would increase the net yield four fold. I have not seen any other extensive irrigation by sewer water in the country, but have observed the principle followed in some parts of Worcestershire in regard to the liquid manure coming from villages and farmsteads, and on which the farmers set great value.

In New Spain I have observed the extensive application of irrigation to wheat land; indeed in that country, where the wheat is remarkably fine, the advantage of irrigation is so manifest, that I may safely say nine-tenths of the entire crop is raised by irrigation. The wheat so treated yields double the quantity of that left to the chances of the atmosphere; thus while the irrigated wheat yields on an average 30 to 1, the other will only yield 15 to 1.

What is the mode of irrigation used on the wheat lands of New Spain?—The wheat is twice floated or watered; first, shortly after the young plant appears above ground in January, and a second time in March, when the ear is about to be developed; but in flat ground, where the supply of water is sufficient, the whole field is frequently laid under water for weeks before the grain is sown, which is considered a great advantage.

Is the water of irrigation applied to wheat lands in New Spain charged with any manure?—Only accidental silt, and perhaps some salts from the volcanic soil of the country. I have, however, been led to attribute to the power of the sun in that country the same stimulus which is supplied by liquid manure in this country.

Is irrigation also applied to green crops in New Spain?—I have observed irrigation applied to Alfalfa, a plant resembling Lucerne, and with wonderful effect, producing rich crops or cuttings once a fortnight, and during several months. The Alfalfa is planted in ridges, and the irrigation passes through the intervening furrows.

Have you observed the application of irrigation to horticultural purposes?—Yes, in Barbary, New Spain, and Andalusia. The practice is pretty similar in all, and no doubt derived from the same source. The garden ground is benched out into square or rectangular plots, and a well and tank being provided on the

highest spot, the water is conveyed from the latter in succession, to every plot in the garden as required. Capt. Vetch, R. E.

The water is drawn from the well into the tank by a wheel and an endless band of buckets, and moved by an ox, or horse, or mule, which are fit for no other purpose, so that the daily expense is trifling, the animal living on the garbage of the garden.

At Cadiz and at the Isla de Leon I have been astonished to see the fine vegetables produced in such gardens, the soil of which is little better than sand, but such is the effect of sun and water in warm countries; but at the places last mentioned they do not neglect applying what solid manure comes readily within reach.

Are you of opinion, from the facts you have observed abroad, that irrigation from the water of sewers might be advantageously applied to grain crops in this country?—The value of irrigation from sewer water will probably prove most valuable as applied to grass land in the vicinity of large towns; but if the liquid manure from them is entirely saved for agricultural purposes, I conceive that after supplying all the grass lands, there will be a surplus available for grain crops, and from all analogy it is reasonable to conclude that the stimulus and material of the liquid manure would produce effects resembling irrigation by pure water in warm climates, though I apprehend considerable experience would be required to regulate the times and modes of application, and the state of dilution of the manure to produce all the fecundity that the principle admits of.

In the sewage of towns, do you consider it practicable to collect and convey the whole of the refuse of the town, and apply it to agricultural purposes?—All the manure which can properly be conveyed by water; whatever can pass through a house drain or a gully shoot. I conceive that the aim of a good system of sewage is to get rid of every cesspool and every partial deposit of filth, and to send the whole by the speediest course through the main sewer into the country; and that not a particle of such matter should be lost or wasted, except in times of floods from heavy rains, when the diluted matter would become too voluminous to be all retained for agricultural purposes; but on such occasions the surplusage would pass off from the main sewer at the point of discharge provided for the circumstance.

Do you consider an abundant supply of water essential to a good system of sewerage?—Most undoubtedly; the finest formed sewers, and the best arrangement of them would be of no use without an adequate supply of water. The drains but furnish the ways or vehicles for transportation; the water is the moving power or carrier, and it is the cheapest that can be procured. In fact the supply of water to a town, and the discharge of the refuse are two branches of the same subject, and unless the water be abundant enough and distributed enough to cleanse the drains, these last would often be more offensive than useful.

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The supply of water in towns flowing from an elevated reservoir into main pipes, and from these spreading by branches through the streets, and finally distributed by service pipes to each dwelling, is just such an arrangement as would be most useful to cleansing away refuse into the sewers, if required for no other purpose; but the beauty of the union of the two subjects is, that the water upon such a system, after supplying all the domestic wants of man, is equally fit for cleansing away dirt and refuse, and at the moment it is dispensed for household purposes it begins again to collect in the house drains, carrying all the house filth with it; the contents of the house drains unite in the street sewer, and gain force for greater scourage by accessions from the street gutters. The street drains accumulate in the main sewers with a great volume of water sufficient for every purpose, and the whole content is at last discharged by one or more mouths ready to be applied to the land for the reproduction of food.

Have you been able to form any estimate of the value of the human excreta from a town in proportion to the amount of the population?—Some agricultural chemists have estimated the value of the liquid excrement of each person per annum for manure at 12s., and if the whole refuse of a town soluble and conveyable by water could be completely conveyed to the purposes of the land, to the value above estimated might reasonably be added half as much more, giving a total of 18s. per head. Leaving, however, such high estimates as not likely to gain credit, however true they may be, few persons who have attended to the subject would hesitate to admit that 5s. per head would be a low estimate for the complete sewage of a large town, and this view of the case more than corroborates the previous estimate. Five shillings a head on 80,000 persons would produce 20,000l., and deducting one-eighth for expenses, leaves 17,500l. as revenue; and it is by no means unreasonable that when the system is rendered complete, value to that amount would arise where the proper extent of land is conveniently situated; but what amount of that revenue would go to the several parties concerned is not easily estimated. But if we assume that a net revenue of half, or 2s. 6d. per head, would result to the townspeople, that in a number of cases would not only suffice to pay for the complete drainage of the town if thrown into a perpetual annual charge, but would also pay for an ample supply of water to the town. Mr. Hawksley has stated, that from 5 years' experience at Nottingham, he had ascertained the cost of delivering 1000 gallons of water under high pressure to be 2.88d.; if we therefore allow 16 gallons daily to each person (which is ample) the annual cost per head is only 1s. 4.8d., but say 1s. 6d., there would consequently remain 1s. per head of annual revenue to defray the expense of laying down the sewers of the town, and this at Leeds on both sides of the river would be equivalent to a principal sum of 150,000l.; but in combining the drainage account with a supply of water furnished on

the high pressure principle, as described by Mr. Thom for Greenock and Paisley, by Mr. Hawksley for Nottingham, and G. W. Anderton for Preston, it is manifest that fires occurring in these towns might be immediately extinguished, and if that duty was to be performed by the Water Company, loss from such a cause could hardly arise, so that the inhabitants might either save their fire insurance; or, what would be a better plan, the Water Company might readily engage to extinguish all fires and compensate all damages for a trifling increase on the water charge. In this manner, if the three objects of supplying water to the town, extinguishing fires, and of sewerage and draining were skilfully combined into one system, and if each town secured the benefits of such a combination to the inhabitants at large, their comforts and conveniences might be met, either very cheaply, or even be entirely defrayed by the proper application of the manure.

Do you apprehend that in the application of the contents of sewers to the purposes of agriculture any great inconvenience would arise from noxious effluvia?—If the system of a sufficient supply of water is united with the drainage, I believe the filth would be carried off nearly as fast as created, or that the water distributed on the soil would be discharged the next, loaded with impurities before it had permitted of fermentation or foetid decomposition taking place, and that the dilution under such circumstances would render the odours of the sewer water discharged hardly perceptible, and less noxious than the effluvia which arises in London through the gully holes.

Have you compared your views with those of any agriculturists on the subject of liquid manure?—I have had the advantage of discussing the subject frequently with Mr. Smith of Deanston, from whom I have obtained much valuable information, and I have felt much flattered by finding my ideas on this subject borne out generally by his own opinions.

CAPT. DAWSON, R.E., examined.

Capt. Dawson,
R.E.

Have you under your superintendence the surveys in use for the tithe commutation?—Yes.

Have you had occasion to consider of the scale and description of surveys which would be most advantageous for the sanitary improvement of towns—for house, and road, and street drainage, for sewage, for the regulation of new buildings, and for the other public or private purposes to which a comprehensive survey may be made applicable?—I have.

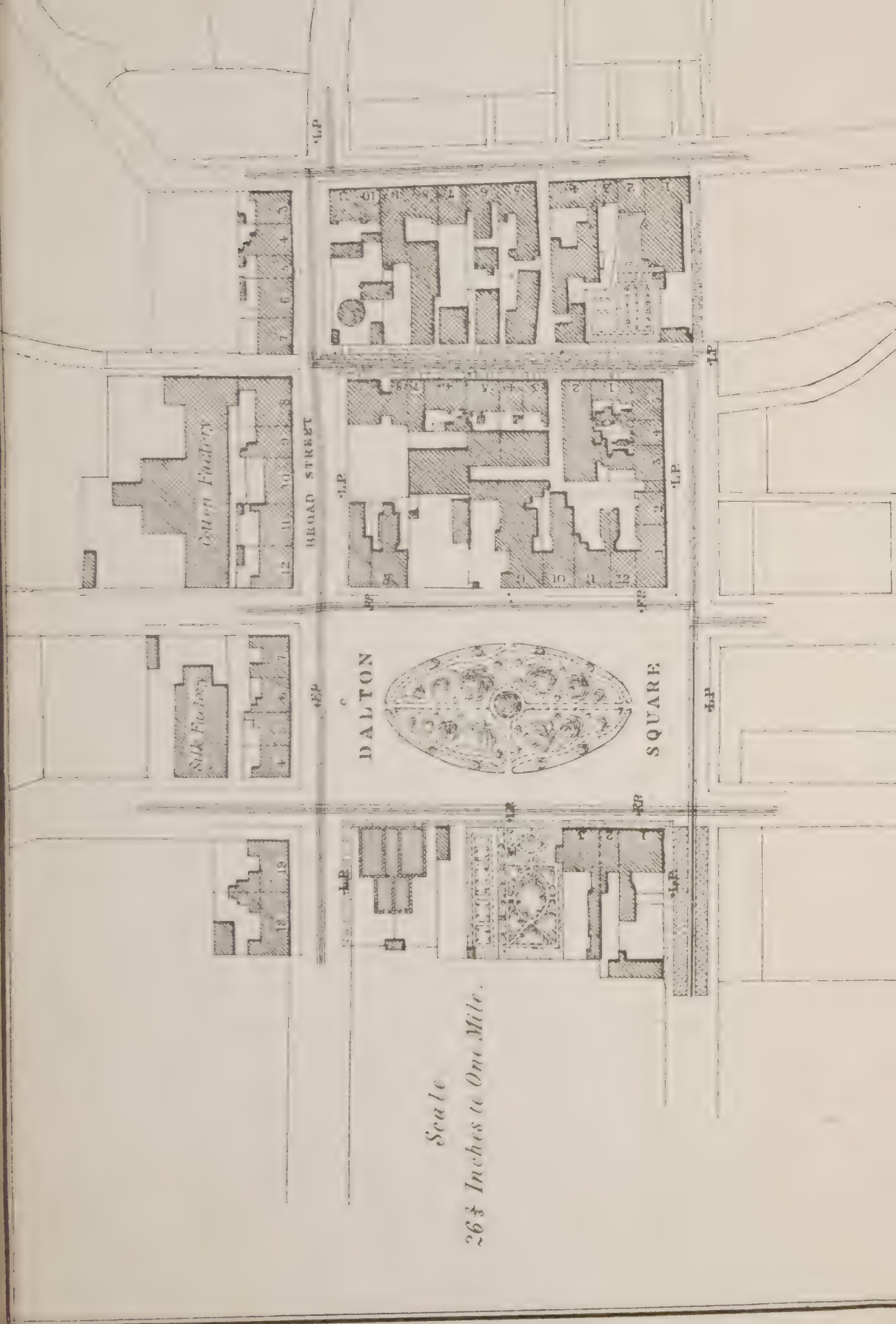
The annexed is a set of illustrations of town surveys at various scales, from the smallest size of one inch to a mile, to the largest, which reaches to a mile, submitted to the Board as illustrative of the scale of maps available for sanitary and other purposes. Which of these scales are in use for tithe surveys and parochial

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valuations?—[*The several specimen maps were shown to the Witness.*] The scale of 26 inches and $\frac{2}{3}$ inch per mile is the scale prescribed for our first-class maps. This scale is, however, applicable only to the rural districts of parishes, and to fields, and other subdivisions of a moderate size. For instance, acres and roods, or even half roods, may be satisfactorily represented on this scale; but where houses and small tenements are to be shown, the quantities of which amount only to a few perches, a map on a much larger scale is indispensable for the clear and accurate representation of such minute subdivisions. The maps of towns in the Tithe Office are for the most part on the scale of 1 inch to 1 or 2 chains (*i. e.*, to 66 or 132 feet), or from 4 to 80 inches to a mile. Some few maps have been supplied on intermediate scales; and one only (that of St. Clement's Danes parish) on the scale of 1 inch to 30 feet. An intermediate scale of 5 feet to 1 mile, or 1 inch to 88 feet, or 60 inches, has been adopted by Colonel Colby for maps of some of the larger towns in Ireland, and is now being used by him for a similar purpose in the six northern counties of England. This scale is fully sufficient for the purposes of tithe commutation and parochial assessment, and would, in my opinion, be found sufficient generally for sanatory surveys.

It is stated that the map at the larger scale of 60 inches to the mile is the one most eligible for sanatory purposes, as being the one on which lines of house and street drainage may be most conveniently laid down, and on which the distribution of water-pipes, the stations of fire-plugs and fountains, may be shown; also the lines and direction of gas-pipes, and the stations of gas-lamps and other objects may be displayed. Characteristic marks have been inserted on the premises to render the map useful for the purpose of rating and valuations. With an engraved copy of a map so marked, it is suggested that any public officer making valuations may go over a whole district and catch in a general way any account read from a rate book, and with the omission of any sort of premises, such as stabling or out-houses, which may appear not to have been rated. So also, with such a map the collection of the rates may be checked. If building improvements of new lines of road be under consideration by the formation, it is deemed that the marks characteristic of the different descriptions of premises and their occupancies will give a new and additional value to such survey in showing at once the general nature of the property that would have to be taken down, or that would be affected by the proposed undertaking. How far does your experience enable you to concur in these views?—Undoubtedly such a survey, containing characteristic or conventional signs, would be highly valuable for such purposes. It would save much expense.

You would, perhaps, consider it an important addition to



Scale
26 1/2 Inches to One Mile.

Cap

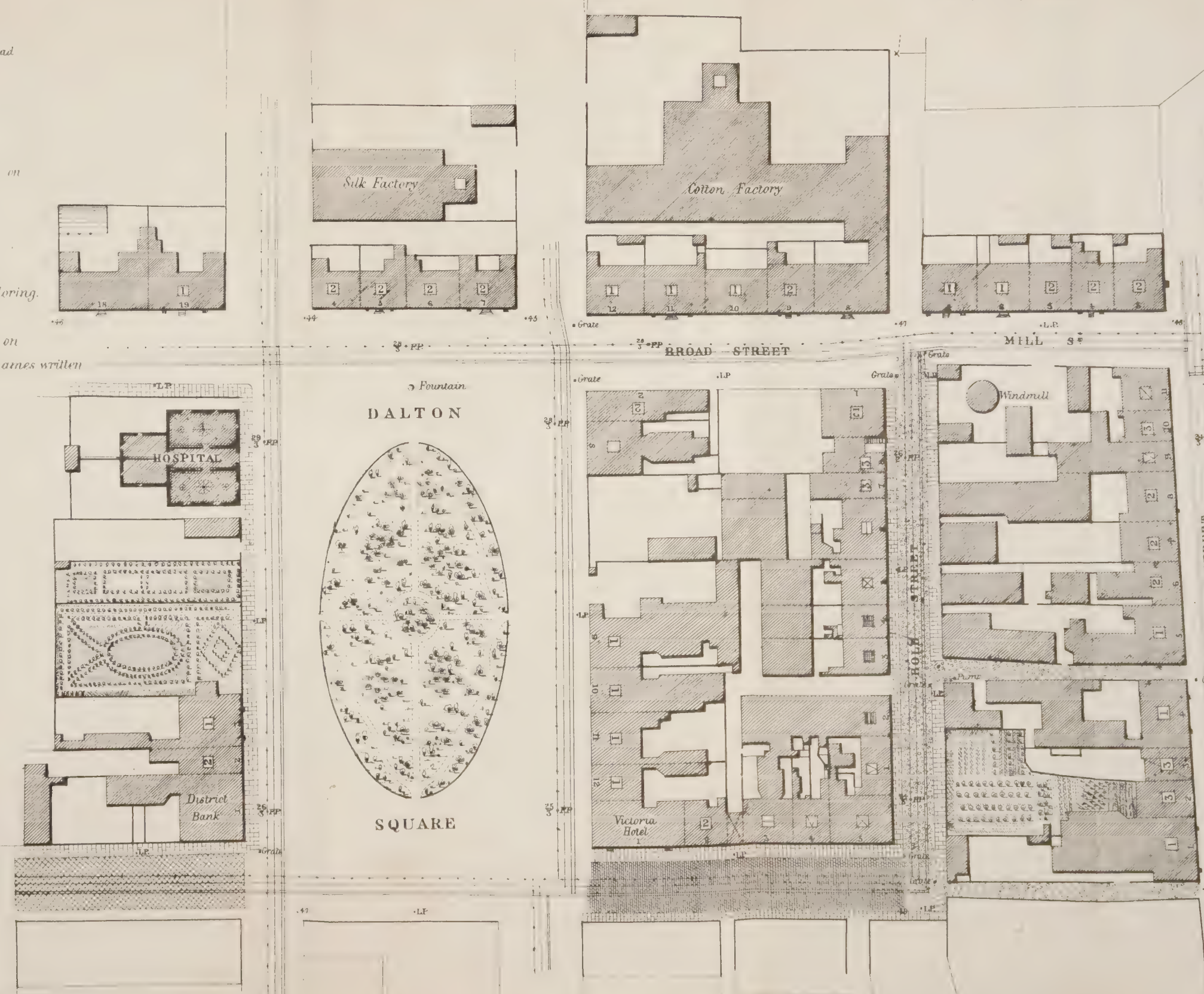
Specimen Plan containing the characteristic Symbols to render engraved copies practically useful for valuations, the collection of rates, and other public purposes.

SYMBOLS to be used on the PLANS

- Sewers The number 8 shows the bottom to be 8 feet below the surface of the road
Water Pipes
Gas Pipes
- Chimneys of Furnaces that consume the smoke
Do. that do not consume the smoke
- 1st. Class Houses in which there is not any business or trade carried on
2nd. Do.
3rd. Do.
4th. Do.
- Houses with offices and shops
Do. in which manufacturing is carried on, as Shoemaking, Tailoring, Carpentering, and Hand-loom Weaving
- Houses in which manufacturing injurious to the health is carried on
Inns of the 2nd. Class. — Hotels or Inns of the 1st. Class to have their names written
Public Houses
Houses let by Floors.
Do. Rooms
Common Lodging or Tramp Houses

- Macadamised Streets
- Stone Pavement, Squared Stones
- Stone Pavement, Common Pebbles
- Wooden Pavement
- Flagged Footpaths

- Cellar Grates
- Sewer Grates
- Fire Plugs (Shows that the water will ascend 36 Feet, Pipe 3 feet below the surface)
- Lamp Posts
- Altitudes



value of such surveys that contour lines of equal altitude should be traced upon them (as nearly as the intervention of blocks of houses would allow the surface to be ascertained) to facilitate drainage operations and laying down pipes for the distribution of water, as well as pipes for the distribution of gas?—Decidedly so.

By what means do you test the accuracy of maps brought to your office?—The surveyors are required to send their original field notes to me with the maps for examination; and those notes are required to be kept in ink and to be free from erasures. The lines measured upon the ground are required to be drawn in red ink upon the map, and marked with reference to the pages in the field-books where the notes of the measurements are recorded. It is the duty of the examiner to see that the lines of construction, or measured lines, are systematically and properly disposed; and that the measurements recorded in the field-books are properly indicated on the map. Any discrepancy between the map and the field notes leads to the rejection of the map; and when doubts arise as to the originality of the field notes, or from circumstances of a suspicious nature, such as apparent alterations in the field notes, or an unsystematic arrangement of the lines of construction, recourse is had to testing upon the ground. The ground test consists of straight lines, measured by an independent surveyor, in the form of a triangle, with one or more interior proof-lines. The intersections of fences, and other details determined by these lines, when laid down in position and compared with similar lines drawn upon the original plan, constitute one of the severest tests that can be applied. When maps of adjoining parishes are supplied to me, a comparison of their common boundaries affords an additional test, though the result in this case is not always to be relied on, unless when used in connection with the ground test. The whole number of maps received in the Tithe Office to the present date is 8039. Of these, 2017 original maps from recent survey—the work of 405 surveyors—have been submitted to examination in the manner before stated, and the result is as follows:—

Approved	1,399
Rejected	521
Remaining under examination	97
<hr/>	
Total	2,017

What proportion of the surveys which you are called upon to examine manifest the science or skill for making surveys applicable to sanitary purposes, or such public objects as those in question?—The surveyors, for the most part, are not personally known to me; and it is scarcely possible, from a mere

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inspection of a map made for a specific purpose, to make a fair estimate of the science and skill of the surveyor in other respects. It is probable that, under an efficient system of superintendence and control, a considerable proportion of the 405 surveyors would be found efficient for sanitary surveys, though, of my own knowledge, I could not vouch for a tenth part of the number, and probably not for twenty persons properly qualified to act without superintending control.

What would be the advantages to the public, in respect of economy and efficiency, of surveys made on such a system as that in use under the Board of Ordnance, as compared with surveys made by private surveyors, such as you find called in by parish or union officers?—I am not prepared to say what advantage there would be in respect of economy; because, during the 18 years that I was connected with the Ordnance Survey I had no personal experience in town surveying, and I cannot therefore state, of my own knowledge, what would be the cost of such surveys, if made by a department similar to that of the Ordnance Survey. The map of St. Clement's Danes parish, to which I have alluded, was contracted for at a total sum of 300*l.*, being after the rate of 3*s.* 3¼*d.* per house. The map of West Hackney parish, which I have produced here, was contracted for—

	<i>s.</i>	<i>d.</i>		<i>s.</i>	<i>d.</i>
At	1	4	per acre, and	1	0
Hackney parish, at	1	0	„	1	0
South Hackney parish, at	1	0	„	1	0

The charge per acre adds only a small fraction of a penny to the charge per house; and the experience afforded me by the Tithe and Poor Law Commissions leads to the belief that an average rate of one shilling per house, in towns, would be a low estimate of the cost of surveys and maps similar to that of West Hackney parish, if made by private surveyors, such as are now called in by parish or union officers; the maps so made showing merely the surface occupation of the ground, and being accompanied with a list of the acreable contents only of the several tenements. Fourteen blocks of houses in West Hackney parish, containing from 17 to 83 houses each, in all 626 houses, occupy a total area of 38 acres, showing an average of 16½ houses per acre in the town—which, according to the foregoing estimate, would cost 16*s.* 6*d.* per acre for surveying and mapping. In St. Clement's Danes parish, the total area of which is 53½ acres, and the total number of houses 1833, the average number of houses per acre is 34¼; and the cost of surveying and mapping, at 1*s.* per house, would be 17*l.* 14*s.* 3*d.* per acre. The superior advantage of such a system as that of the Ordnance Survey, in respect of efficiency, would be very great, arising from the peculiar system of superintendence and checks afforded

in every stage of the proceedings, and the rigid adherence to scientific principles irrespective of local influence and all personal considerations.

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Do you concur in the principle that a survey is to be placed on the footing of a permanent work, and that the cost should be spread over a period of years, to be repaid by annual instalments in 20 or 30 years, wherever the amount may not be too small to pay for the expense or inconvenience of collecting the instalments?—I entirely concur in the principle which, if practically adopted in respect to survey, would lessen the objections on the ground of expense to the adoption of surveys of a superior and permanent character. It is assuredly the just principle.

BUTLER WILLIAMS, Esq., C.E., examined.

Butler Williams,
Esq., C.E.

You were engaged some time, were you not, on the Ordnance Survey in Ireland?—Yes, I was employed for five years on various duties of the survey, and subsequently I was engaged in surveying work for the Irish Railway Commissioners.

Have you not been engaged in practical engineering works in England?—Yes, chiefly in railway works, embracing the branches of preliminary and contract surveys, and the subsequent construction of the works.

You are now professor of geodesy at the college of civil engineers at Putney?—I am.

Have you not been led to direct your own attention, and the instruction of the pupils at the college especially to the surveys and other operations necessary for town drainage, and house, and land, and road drainage; the supplying of water, and conducting the operations deemed necessary for the sanitary improvement of towns?—Yes, I have devoted my attention to the subject of surveys as applicable to the sanitary improvement of towns, and I have used the evidence and facts accumulated in the "Sanatory Report," as texts on which to found special instruction in this branch of the profession of the civil engineer, and I have exercised the pupils of the college in making surveys of Putney and Wandsworth in illustration of the subject.

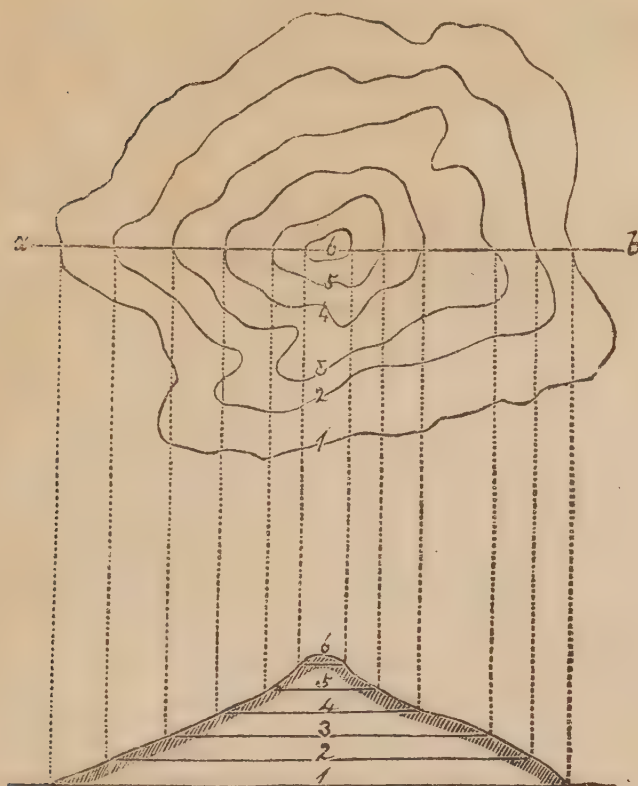
Will you describe the scale and character of public surveys that you deem the best calculated for the carrying out of works of house and road drainage, and sewerage, and for the regulation of new public buildings, and any other public objects to which a survey may be made subservient?—As regards the scale of the plan. For all public works of internal communication and of general drainage, to be carried out or executed in rural districts, I believe that maps plotted to the scale used for parochial assessment maps, and for the first-class tithe maps,

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(i. e. three chains, or 198 feet to 1 inch,) are sufficient for the purpose; and I rest this opinion on my experience of railway and canal surveys, which are usually plotted to a scale of 200 feet to an inch (practically the same as the scale above referred to, but presenting the advantage of a decimal notation in terms of a common measure for heights and distances). The scale of 200 feet to the inch has been found sufficient for the purposes of determining the levels, laying out the works, and for the valuation and transfer of property. For works of drainage or sewerage, or other engineering works, to be executed in towns, the surveys should, in my opinion, be plotted to a larger scale. Sometimes the scale of one chain, or 66 feet to 1 inch, frequently a scale of 50 and even 40 feet to 1 inch, is used; but I believe that the scale used by the Ordnance for town surveys (5 feet to a mile, or 88 feet to 1 inch) is sufficient for the valuation and transfer of property, and for the purposes of designing and carrying into execution engineering works. But *plans* or projections on *plane* surfaces are in themselves very incomplete, if they do not exhibit, in addition to the simple projection of objects, roads, &c., the undulations of the ground, and all the variations of level. For the due exhibition of these, therefore, I consider it essential that a clear conception of the undulations of the ground should be given by means of a well arranged system of contour lines of equal altitude, the system presenting all the advantages of a model in relief, with the additional recommendation of greater accuracy both in the abstract and for practical purposes.

Will you describe, for the information of non-professional persons of the Board, the origin and the principle of contour lines of equal altitude?—So early as 1742 an essay, proposing the adoption of contour lines on maps, was read before the French Academy of Sciences, the idea having been suggested to its author by the traces left by a great inundation which occurred two years before. To give an idea of the principle of contour lines, we may suppose a hill, or any elevation of land covered with water, and that we want to trace the course of all the levels at every 4 feet of vertical height; suppose the water to subside 4 feet at a time, and that at each subsidence the line of the water's edge is marked on the hill; when all the water is withdrawn, supposing the hill to be 24 feet high, it will be marked with a set of six lines, denoting the contours of each of the levels, exactly 4 feet above each other. The marks thus supposed to be left on the hill being surveyed, and drawn on the plan, would supply information more exact than a model in relief. For when the heights are to be referred to on the model, they must be re-measured with chances of mechanical error greater than those presented by the plan. The plan with the contour lines gives by inspection the recorded heights as

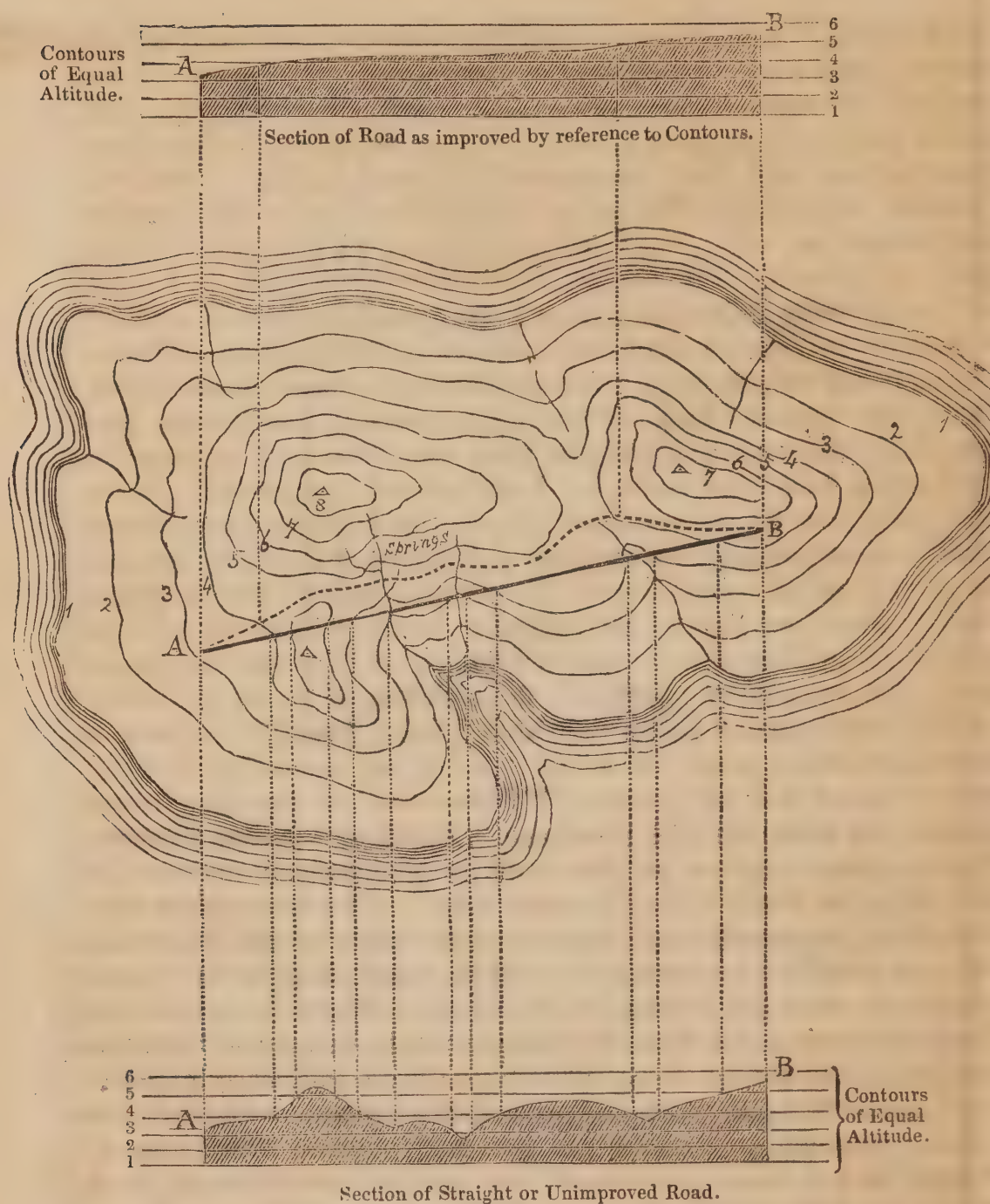
Plan.

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Section.

obtained from *direct measurement in the field*, whereas the model gives them only when deduced by a *secondary process* from measurements on the diminished scale. The want of accurate outline maps prevented the idea from being carried out at the early period referred to; but from time to time the subject was re-considered, and after having been used in special cases, chiefly for surveys, having reference to the supply of water, the contour lines were adopted on the French cadastre in 1818 as a part of the general operations of the survey. Contour lines have also been adopted for the Irish survey since the year 1838.

Will you explain the use of the contour lines of equal altitude?—To illustrate the use of contour lines, let a road surveyor be requested to lay out a line of road from A to B (see annexed sketch), he could, by reference to contour lines drawn within sufficiently close limits, select such a direction as would give the most favourable *gradients*, without taking any trial levels, or even visiting the locality. He could, for example, obtain from the plan the section or varying gradients of a road in the direction represented on the sketch by the straight line A B, and compare its length and its gradients with those of a line of road made to deviate in such improved directions as would be indicated by the contour lines, generally (as shown by the dotted line in the above sketch) increasing in a slight degree the total length of the road.



but avoiding back-falls, and reducing the gradient to a minimum amount of steepness by spreading the total rise or fall almost evenly throughout the whole line of road. The saving in time by reference to such a map is self-evident, inasmuch as no preliminary levelling would be required, and the saving in expense could not be less than the cost of levelling from four to five times the whole length of the line of road; for it is but rarely that even a common road of considerable length could be set out in the most advantageous manner without at least half a dozen trial-sections. Such trial-sections, after they have served the immediate purpose required, become useless for any other work, whereas levels taken for contour lines are always ready to be referred to for any project of internal im-

provement. But the use of contour lines would become even more important to an engineer engaged in setting out a railway or canal. The necessity for easy gradients in the first description of work, and of level lines in the second, render deep excavations and high embankments unavoidable. The proportion of saving in the cost of these great works, that may be the result of even slight deviations, can scarcely, in a broken and varied surface of country, be over estimated. Indeed, many of the existing lines of railways in the kingdom present striking examples of unnecessary expenditure in cuttings or embankments that might have been avoided, or greatly diminished, had the engineer had access to trustworthy documents, presenting, under one connected view, the relative elevations of adjoining hills and valleys. Such a connected view is offered in perfection by the contour lines; but the short time which must usually elapse between the formation of a project and the introduction of a Bill into the House, allows the engineer little more time than is requisite for the levelling and surveying of several trial-lines; and, indeed, the expenditure in money required for a more extensive and connected series of levels, which would amply repay the outlay when applied to various works, would scarcely be warranted for an isolated project for which, after all the outlay, the sanction of the legislature might not eventually be obtained. When a Bill for a railway, navigation, or other public work is enacted, the extent of deviation is limited to 100 yards from the parliamentary line, but very frequently such limits do not admit of the execution of practicable improvements, which become apparent to the engineer when he has more time and money to bestow on the investigation of the most economical means of carrying out the project; but rather than incur the risk of increased expense and opposition in passing a new Bill in Parliament, the first line is retained and completed, although with the certain knowledge that a more economical line might have been selected. Such contingent difficulties—and they are of frequent occurrence—would be avoided if the projecting engineer had had access at the first to accurate maps with contour lines, on which he could implicitly rely. But the probable, and, indeed, assured economy resulting from contour lines may be exhibited also in the more advantageous selection of a line of communication within the limits of 100 yards prescribed by the Acts. I have been engaged in cases in which ten or twelve longitudinal sections, connected by transverse sections, have been taken for the purpose of determining on the most economical line that might be executed within the prescribed limits after the passing of the Act; and in those cases referred to, as well as in many instances that have come within my knowledge, a saving of several thousands of pounds per mile, has been the result of a judicious expenditure of time and money on these surveys.

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preparatory to the letting of the contracts. But the engineer always urged by proprietors to commence the works without delay, has it not always in his power to devote months to these most important preliminary surveys, the value of which is not sufficiently appreciated by the shareholders, and he is thus placed in a difficult position, from which he would be relieved had he access to a plan with contour lines. In thus weighing the advantages of contours, account must be taken of the not inconsiderable expense required for taking these trial-levels which become useless for other purposes than those for which they are immediately undertaken—whereas, in the case of contour lines they are at all times useful and ready for reference for every description of work, while they offer the great advantage of presenting a connected view, instead of isolated sections.—The same knowledge of the levels of a country which, conveyed by means of contour lines, is applicable to the setting out of railways, is of course equally available for canals. Indeed, for these works the contours themselves exhibit the level lines which they are frequently made to follow.—The contour lines again become available for the conduct or supply of water. If, for example, it were required (see sketch) to supply the towns A or B, with water from the stream and springs shown on the sketch between A and B, the contours would indicate the part of the course of the stream where a reservoir might be advantageously formed by throwing an embankment at such an elevation across the valley, that all the water in the supposed reservoir would become available for the supply of the town. Also, if it were sought to irrigate a property on either side of the stream, the contour lines would again indicate that part of the stream in which the erection of a weir, or dyke, would enable the water to be diverted to fertilize the proposed district.—Again, for the purpose of the draining of marshes, or indeed of any district of country, contour lines would indicate the nearest and most rapid outfall for the surplus water. In short, there is no species of work for any internal improvement for which levels are required that might not be devised and projected by means of the contour lines, drawn within the proper limits of vertical equidistance.

What vertical equidistance would you recommend for the contour lines?—These limits of the vertical equidistance should, in my opinion, be made to vary according as the contour lines would refer to town or country districts, and also according to the natural features of the country to be represented,—the general rule being, that the flatter or more even the country, the less should be the vertical equidistance.

Do you concur in opinion with Captain Vetch in recommending four feet as the proper distance for the contour lines in towns?—For towns built or to be built on regular natural

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surfaces with steep falls, I believe that contour lines, with a vertical equidistance of four feet, would suffice; but for flat ground, or ground very irregular in its form, or for ground liable to be flooded, two feet would be a good vertical equidistance. Such contours, projected on a plan plotted to a scale of five feet to a mile (the Ordnance scale for towns), would convey all the information required for sanatory and structural improvements. Contour lines, drawn with a vertical equidistance of one metre, were found by M. Girard, engineer to the water-works of Paris, sufficient for all the purposes of the water-works; and it may be observed here that the plan adopted for watering the streets of Paris by fountains (*bornes-fontaines*) demanded a very exact knowledge of the levels; for the site of these fountains had to be so selected, that, by placing each in a culminating point of a street, it might be made to water the greatest possible extent of surface.

Would a distance of two feet between each contour be sufficient to guide builders in the formation of private house drains?—Yes. The vertical equidistance proposed would suffice to guide builders in their private drainage. But to assist them more effectually, and in general for the purpose of reference by all designers of physical and structural improvements, it would be highly desirable that, in addition to the careful registry of the altitudes on maps accessible to the public, exact indications of the levels should be inserted at convenient places on public permanent objects. The heights, all referred to the same datum, should be inscribed in feet on the public buildings, and at the corners of streets in towns; and in the environs of towns, on milestones, gateways, or any convenient fixed object.

State to what other purposes such contour lines might be applied with advantage?—Contours thus regulated, would supply the necessary information for the most advantageous distribution of the sewerage. They would likewise suffice to guide in the improvements of the levels of streets, when any repairs should offer opportunities of diminishing irregularities in the gradients at a small cost, and they would, as a matter of course, be referred to in laying down the water-pipes. Contours representing by a *combined* view all the points of elevation, would be of great value in the designing of plans, and forming estimates for new districts of towns.

Would you propose adopting the same vertical equidistance between the contours for the country districts as that which you recommend for the towns?—For country districts, tracing an even surface or gradual swelling features, contour lines with a vertical equidistance of four feet would be sufficient, not only for all purposes of road, railway, or canal projects, but also for the very delicate operations of drainage and irrigation. In districts presenting swelling and rounded

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forms, without abruptness, but with more marked falls, contour lines separated by a vertical equidistance of eight feet, would, I believe, be sufficient; and in still more hilly districts, the contour lines might be traced even wider apart.

Should the public survey embrace other details in addition to the ground plan or projection of objects, and the exhibition of the levels by contour lines?—Yes. Among other essential points I would name geological details and statistical returns. Successful and economical construction of roads, works of drainage and sewerage, appropriate selection of sites for new buildings are so dependent on the knowledge of the facilities and materials afforded by the geological formation of the district, that the surveyor should call in the aid of the geologist to make his survey complete in this respect. To prevent confusion by over-crowding the map, the geological features might be coloured on separate sheets. And as regards statistical details, the materials, character, and uses of the public buildings and private houses erected, the different constructions of the roads, the courses of the existing sewer, gas, and water pipes should be exhibited; and (when embracing the whole district) the average extent of traffic, and additional statistical details having reference to internal structural improvements, might be marked by varying corresponding densities of shade, or other conventional signs, such as those adopted by the Irish Railway Commissioners, to represent to the eye a great body of most valuable statistical details bearing on the state of commerce, population, &c.

Upon a sufficient horizontal scale (such, for example, as that recommended for town surveys), do you prefer for sections an exaggerated or a true vertical scale?—I consider adherence to the true vertical scale for sections to be decidedly preferable, when the horizontal scale is sufficiently large.

Can you furnish a specimen of a map constructed as you describe?—In order to supply physical data for a Sanatory Inquiry, several students of Putney College, (Messrs. Curtis, Lee, Hill, Scott, and Mahon) prepared under my direction a map of the City of London, from a portion of which the annexed copy is taken. The specimen embodies some of the points which I have enumerated, and, among other details, shows contour lines separated by a vertical distance of two feet. I may mention that the contour lines are marked on this map thicker than would be recommended for general use. They have been made thus prominent, because the specimen produced is partly for the purpose of introducing contours of equal altitude into more general use than has been hitherto done. The outline map itself is simply a compilation from existing documents, and is not put forward as accurate, for there does not exist at present an accurate map of London. But the specimen shows that the contours are a sufficient guide as to

CITY OF LONDON.

Rough Draft of the City with Contours of equal altitude
Levelled by Mess^{rs} Curtis, Lee, Scott, Mahon & Hill,
Students of the College for Civil Engineers.

Butler Williams,
Professor of Geodesy,
23rd March, 1843.

REMARKS.

The Datum is 10 feet below the top of the Cap Stone at foot
of Steps, East side of Blackfriars Bridge.
The Vertical Equidistance of the Contours is 3 feet.
The Numbers near each Contour, along the external boundary of
the City, indicate the height of the Contour above Datum.
At the Bridge Approaches the Contours are continued in dotted lines,
along the natural surface of the ground,
which is raised artificially so as to interrupt
their continuity.

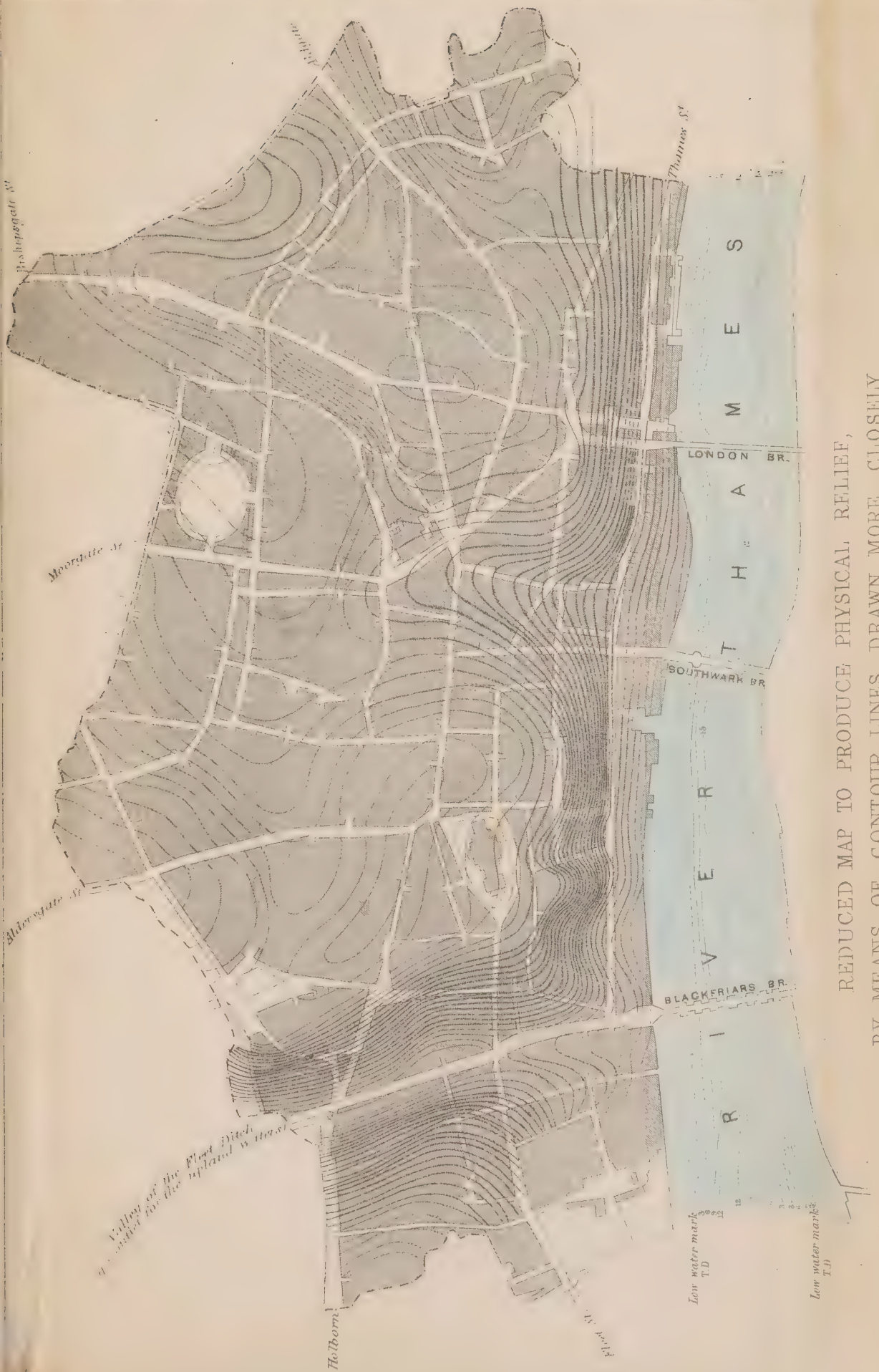
SCALE OF THIS MAP.

$\frac{1}{7920}$ of actual size
10 Chains to one Inch
or 8 Inches to one Mile
or 660 Feet to one Inch.

PROPOSED SCALE FOR DETAILED MAP.
As exemplified on Specimen Plan (N^o 2) of the neighbourhood of St Pauls

$\frac{1}{10560}$ of actual size
60 Inches to one Mile
or 88 Feet to one Inch.





REDUCED MAP TO PRODUCE PHYSICAL RELIEF,
BY MEANS OF CONTOUR LINES, DRAWN MORE CLOSELY.

The contours in the river indicate the actual depths at low water



Rough Draft of Part of the **CITY OF LONDON,**

With Contours of Equal Altitude, & Statistical Details.
prepared by M^r R.W. Curtis, Student of the
College for Civil Engineers.

Butler Williams,
28th March 1843.

NOTE. The Statistical Details embodied in the Map may be varied according to the nature of the local object for which the Map is especially prepared. The Details given here suffice to show, how information required for valuation, rating or similar purposes might be embodied on a Map for general reference. By the additional aid of Color, further details might be introduced, and with greater clearness.

- (The Figures written on each house denote the actual Number of each house in the Street.)
- Private Houses (those occupied by persons not in receipt of Wages)
- Chambers, Offices, Shops, &c
- Houses occupied by persons in the receipt of Wages.
- Warehouses
- Stables and Outhouses.
- Flagged Footways
- Paved Roadways

- Public Buildings
- Contours. The Figures denote the height in Feet.
- Sewers
- Gas Pipes
- Water Pipes
- Gully Gratings
- Lamp Posts
- Fire Plugs

NOTE. All the Lamps in this part of the City are fixed to the sides of the Houses excepting in Ludgate Street and St Paul's Church Yard

Vertical equidistance for Contours 2 Feet
Datum 10 Feet below the top of Capstone foot of Stairs Blackfriars Bridge

Scale for Feet to one Inch. 100 Feet to a Mile

levels, for the engineer to select the proper lines of drainage and sewerage. To enable the engineer, however, to determine on the leading lines of general drainage, and to devise the best means of obtaining supplies of water, it is necessary to be able to embrace at one view an extent of country much greater than could be presented on a scale so large as that which I would recommend for town surveys to guide in the detailed engineering works. I have prepared a reduced plan of the City of London, in which the contour lines, by being brought more closely together, produce the effect of physical relief, and exhibit by their approximation the lines of natural drainage for an extensive district. This physical relief is especially useful for non-professional persons, who, having no familiar knowledge of maps or projection, are yet likely to act as representatives of the parties interested in sanatory improvements. We see, for example, in the smaller plan produced, the valley which, intersecting the city from north to south, points out the natural and most ready outlet for the upland waters passing from the north of the country through the Finsbury district towards the Thames. It is also necessary to have a reduced plan of this kind to be able to acquire a knowledge of the area of the country which forms a natural basin or trough to be drained by any particular outlet. The exact knowledge of the extent of this area is indispensable to enable the engineer to provide sectional areas for his sewers sufficient to drain the waters that may in the case of a sudden and heavy fall of rain accumulate towards the natural outlet. All proceedings to drain parts only of a natural basin must be very expensive, and at the same time imperfect. The aid of the geologist would also be called in by the surveyor, for the purpose of embodying on his map, or connecting with it the geological facts which are important in estimating the probable quantity of water that may be obtained, the requisite strength of proposed structures, and the relative proportion of the parts of the hydraulic works connected with the drainage and sewerage.

These maps which you produce, as exemplifying points having special reference to the objects of a sanatory inquiry, appear to embrace details, and to embody information more various than it has been the practice hitherto to introduce on maps or plans?—They do; and I would beg leave to direct the attention of the Commissioners to them, because they show that maps may, by a more careful construction, be made the vehicle for more useful information than has been hitherto furnished by them. These are parts of surveys that were prepared, as I have stated, for a sanatory inquiry, and they embody some of the improvements in surveys which have been suggested by Mr. Chadwick, in order to render them particularly useful for valuation and rating, as well as general statistical and sanatory purposes. With an engraved copy of

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such a survey as that marked No. 20, one public officer would go with his valuator over the houses numbered, and check the rate-book as read by another officer. If stabling or back premises connected with any house were omitted in the rate-book, the map would show what had been omitted. The tax or rate collector would check his collections by it; and rate-payers would not be unduly charged, or property be unduly burthened by undue omissions. Medical visits and the duties of parish or municipal officers might be regulated by such printed maps, which, instead of being locked up as muniments, would come into daily and important use, if they were skilfully constructed on the plan which has been suggested. If a new line of street, or any public improvement were in question, such a map would at once show the description of house property through which such a line must pass. When examining the evidence published in the last Report of the Metropolitan Improvements Commission, and former reports having reference to the same inquiries, I have been particularly struck with the great assistance that the Commissioners of Inquiry would have derived in their investigations had they had such maps to refer to; for the witnesses generally, when dwelling on the comparative merits of various proposed lines, find it frequently necessary to refer to the class of house property that would be interfered with by one or other of the projects under view, as influencing in a material degree the probable cost. Such references would be made at once with precision were the proposed lines marked on maps of this character. The statistical and other information to be exhibited on the surveys might be varied according to the special or local object in view; and, with the addition of colour, many more details might be introduced without confusion. But these specimens will at least demonstrate the practicability of such surveys being made applicable to uses which have not hitherto been contemplated.

Would not such a survey and map as you describe also supply the data necessary for the projection of new lines of drainage, or the improvement of the existing lines?—Yes, and the directions of the lines of drainage would guide in projecting the future increments of towns; and builders and proprietors would gladly avail themselves of such valuable information presented in an authentic form.

Will you state the advantages to the public, derivable from surveys such as those of the Ordnance, in respect to accuracy and economy, as compared with surveys made by private surveyors?—There is adopted for the various operations of the Ordnance survey, a system of independent checks on the accuracy of the work, which efficiently guards against the possibility of errors remaining undetected. With the surveying works of the Ordnance, the most exact truth in every part is the primary

object kept in view, and every, even the most subordinate operation, is executed with all skill and scientific care. Viewed in an economical aspect, an Ordnance survey presents, therefore, this great superiority, that the work is correct, and that the public and the profession, have confidence in its accuracy. Whatever is published by the Ordnance Survey Department is accepted as correct. This consideration is by no means unimportant in an economic aspect, for I can well imagine many cases, and I have known of several, in which surveys, made by surveyors of acknowledged skill, for a special purpose, would not, and in fact could not, fairly be expected to be used by an engineer as a basis on which to found some design for a public work. For if such engineer have no personal knowledge of the surveyor, by whom the survey may have been made at some antecedent period, he would naturally hesitate to intrust the contingent stability or efficacy of his works, or his own fame, to the chance accuracy of the plans and levels; he thus feels himself called upon to incur expense, if not for a new survey, at least for a minute, and therefore expensive testing of the old. Whether this be reasonable or not, it at any rate leads practically to the repetition of surveys of the same district. Now, with an Ordnance authorized map, such cases would not occur. As regards the actual comparative expenditure for a survey to be made by the Ordnance, or by private surveyors, I believe that the vast and combined operations of the Ordnance survey might cause the work to be effected more economically, but on this point I am not able to speak with certainty.

Of the surveys made by private practitioners, for trading or other bodies, what proportion of such surveys have on the face of them exhibited the proper qualifications?—A large proportion of the surveys made by private practitioners for the great public works lately executed in England, is of a good description, because the public bodies requiring those surveys can command, and do obtain generally the best qualified. But even on those public works, cases of inaccurate and insufficient surveys have come to my knowledge. This might result partly from imperfect qualifications, and partly from the habit of letting the surveys by contract. I believe that there are practising surveyors who would not be competent to execute surveys requiring that great truth of execution demanded for sanitary purposes, and which the Ordnance, by its efficient scientific staff, can ensure; but my experience is not sufficiently extended on this point to enable me to give precise or valuable evidence. This much I know, that surveys made of late years have frequently brought to light evidence of the inaccuracy of previous maps for the determination of acreage. Fields, known in their localities by the name of “five acre,” “six acre,” “seven acre” fields, &c., and let to the tenants as if containing

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such quantities, are found to have been generally under estimated, sometimes so much as 10 or even 15 per cent. Proprietors are becoming aware of this, and in those cases where either tithe maps or Poor Law assessment maps do not give opportunities of correcting errors of this nature, they not unusually have new surveys made, previously to granting new leases. I would observe that such under estimates of quantities arose from the erroneous practice adopted formerly, of making isolated surveys of each field, and also from not extending the measurements to the boundary, but confining them so as not to include the neglected parts near the fences, which careless husbandry frequently allowed to lie waste. The mode of conducting the operations for parish surveys by great lines, embracing the whole district to be surveyed, described in Captain Dawson's "Instructions to Tithe Surveyors," is now universally adopted, and no acknowledged surveyor would now proceed with isolated surveys of separate fields, to be afterwards combined into a general map.

Would even good separate surveys of parishes, when they had to be combined into a general map, produce results as accurate as those of a general survey, conducted under one general superintending authority?—They would not. In surveying operations, to work from the whole to parts ought always to be the aim of the surveyor. To form a combined map by separate parish surveys, would be working from the parts to the whole, and in such a process errors would accumulate, and soon become manifest in the impossibility of fitting the detached parts correctly together.

Do you know of any case in which such a combined map is formed by reference to detached surveys?—Yes, the French Cadastre Department adopts this method partly. The great operations of triangulation are performed as a whole and with every resource of scientific knowledge and practised skill; but the detail is obtained from detached surveys made with much less system than might have been expected. The surveys of the "communes" are made by under-surveyors, who adopt such means of operating as they each think fit, some using the chain alone, some adding the theodolite, and others the very imperfect instrument called the graphometre. These surveys of the "communes" are tested by a director of the cadastre, who, however, generally himself contracts for the surveys, and is not, therefore, the best officer to test their accuracy. These detached surveys are used for the valuation and register of

property, and are plotted to a scale of $\frac{1}{1250}$ or $\frac{1}{2500}$; (rather

less than the scales of $1\frac{1}{2}$ chain, and of 3 chains, to one inch respectively). Each commune is then bound by law to

supply the Survey Department of the *Depôt de la Guerre*, (an office corresponding to that of the Ordnance Survey-office, in this country,) with certain copies of the maps so prepared. These are combined, and reduced for publication to a scale of $\frac{1}{80,000}$, a scale so small as to disguise all errors. But

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if it were desired to combine and publish the detached maps on the large scales of $\frac{1}{1250}$ or $\frac{1}{2500}$, they could not be fitted to-

gether at the boundaries, and, in fact, could not be combined.

Is not the greater comparative division of labour that obtains in a general national survey likely to produce more accurate results?—Yes. With the work of the private surveyor there are only two divisions of labour, that of the principal surveyor and that of the labourer and chainman. In a national survey there are many subdivisions. In the Ordnance survey, for example, the superintendent, with his staff, conducts the great or primary triangulation. The secondary triangulation is performed as a work distinct from the first, but of which the results must correspond; and again with the tertiary triangulation is followed a similar system of independent work, of which the results must also bear the test of comparison with those obtained by other means for the secondary triangulation. Then, subordinate to those who conduct these operations, there are subdivisions of surveyors of detail, computers of areas, levellers, draughtsmen, labourers, and others, who each in their own sphere attain to great accuracy of work and facility of execution.

Have you had occasion to examine the forms of sewers?— I have examined, among others, the forms of some of the sewers in the metropolis; namely, those of the Westminster, the City, and the Finsbury and Holborn districts.

Have you compared the qualities of those sewers in respect of economy of materials, strength, and adaptation to the free passage of water?—The difference between the Finsbury and Holborn and the City of London sewers is very inconsiderable; both are designed on the same principles, and with the same views toward economy of materials. In answering the question I would therefore compare the Finsbury (Fig. 1) and the

Fig. 1.

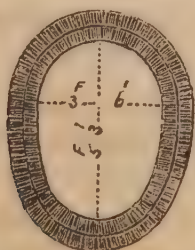


Fig. 2.



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Westminster (Fig. 2) sewers, respecting the form of which there exists a wide difference. First, as regards economy of materials, the upright sided sewer with horizontal footings requires for the same water-way a much greater number of bricks than the egg-shaped sewer. Comparing sewers of the same capacity as the first class in the Westminster district, it is found—

that the upright sided sewer contains,	
for one foot in length	261 bricks,
that the egg-shaped contains, for one	
foot in length	175 „
One mile of the first would require,	
therefore	1,378,080 „
One mile of the second would require	924,140 „

One mile of sewerage of the upright form would require upwards of half a million of bricks more than one mile of the egg-shaped sewer. And the number of bricks that would complete one mile of the upright formed sewerage would suffice for one mile and a-half of the egg-shaped sewer. The number of cube yards of brickwork per mile of sewerage would be—

for the upright sided sewer . . .	3,388 cube yards,
for the egg-shaped sewer . . .	2,272 „
giving an excess for the former of	1,116 „

which, valued at 20s. a cube yard, would amount to 1116*l*. But the excess of expenditure would not be with the brickwork only. The width of the footings used in the upright sided sewer causes great additional expense in the excavation. The gullet must be excavated at least 18 inches wider than for the egg-shaped sewer. The depth to which the excavations of the main lines have to be carried averages generally 20 feet. Taking this as one of the data, the excess of excavation due to the adoption of the upright sided will be 30 per cent. (or as 130 to 100) above the excavation required for the egg-shaped sewer. The number of cube yards to be excavated for a mile in length at the stated depth would be—

25,420 cube yards for the upright sewer,
19,555 cube yards for the egg-shape,

which shows an excess in excavation of 30 per cent., or at the rate of 5,865 cube yards per mile. £. s. d.

This excavation, valued at 1 <i>s</i> . per cube	
yard, would amount to	293 5 0
which, added to the value of the brick-	
work	1,116 0 0
filling in 5,865 cube yards over the	
sewer, at 3 <i>d</i> . per yard	73 6 3

Carried forward 1,482 11 3

	£.	s.	d.
Brought forward	1,482	11	3
excess in carting 1,116 cube yards, at 2s. per yard	111	12	0
excess in repairing 880 superficial yards, at 1s. 6d. per yard	66	0	0

gives an excess of 1,660 3 3

or, in other words, a loss per mile to the rate-payers of upwards of 1,600%. on these items only.

The accompanying sketches are designed to show at a glance, and without reference to numbers, the economy of materials in brickwork alone that must be the consequence of adopting the egg-shaped in preference to the upright-sided sewer.

Fig. 3.

Fig. 4.

Fig. 5.

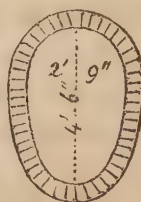
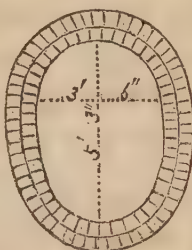
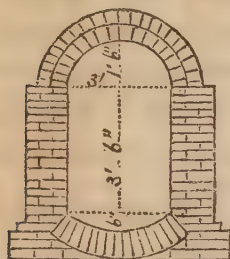
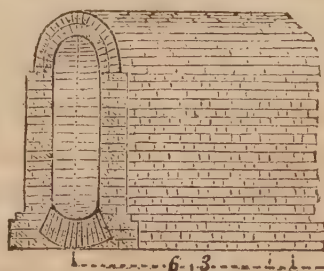
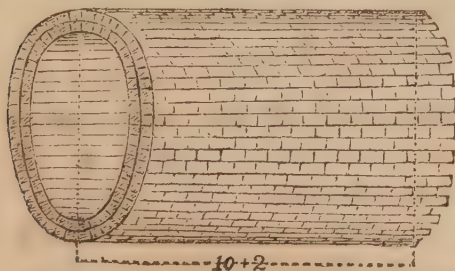


Figure 3 is the section of the Westminster sewer, and figure 4 that of the Finsbury sewer, equally strong, and containing so much less material as to provide, in the difference, for the construction of a sewer somewhat larger than figure 5, which is one used successfully in the Finsbury district for streets or places of short lengths.

Figures 6 and 7 show the comparative lengths of egg-shaped and upright-sided sewers, that may be constructed out of the same quantity of materials, both having the same amount of water-way, and the egg-shaped form offering the additional advantage of greater efficiency as a water channel, and certainly not inferior in strength.

Fig. 6.

Fig. 7.



Have you considered what might have been the total saving in a period of years, if the more economical form (supposing it to be adapted to the purposes required) had been adopted in any particular district instead of the upright sided sewer?— That the egg-shaped sewer is adapted to the purposes required,

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is proved by its successful adoption with various modifications in several of the Commissions. To form an exact estimate of the total saving that might have been effected for the last 10 years in the Westminster district, it would be requisite to have a document giving the sections of all the sewers constructed, and I am not aware that such a document has been published. But it is stated that 40 miles of covered sewers have been built in the district in the last 10 years. These new sewers comprise some larger, some smaller, than the size to which the preceding estimates refer, and as they moreover omit the private sewers which must by the regulations be built in the expensive form described, we may fairly take 40 miles of sewers of the above size as probably below the quantity constructed in the period named. This, at 1660*l.* 3*s.* 3*d.* per mile, gives a positive loss of 66,669*l.* 15*s.* in 10 years, a sum sufficiently startling to cause the inquirer to scrutinize with care the reasons that are advanced in favour of the adoption of a form theoretically imperfect, and found practically not to answer so well in some cases as the more perfect theoretical shape which would produce such a great saving.

As bearing on the economy of materials, are there any other changes in the construction which would produce positive advantages?—Yes; by the use of a system which would render cleansing by hand or by casting unnecessary, the many man-holes or apertures now required, and ordered by the regulations to be placed opposite all intersections of sewers, and at distances seldom exceeding from 50 to 60 yards, would be no longer needed. In this particular, an additional saving would be effected: and when we consider the number of miles of covered sewerage in the metropolis, which I suppose cannot be less than about 500 miles, we can form an idea of the saving or waste, as the case may be, which must result from the adoption of one or the other plan. Then in the case of the gully-holes also; they are generally made wastefully thick, and unnecessarily wide; and it appears to me that Mr. Dyce Guthrie's recommendation of the substitution of strong tube tiles, one foot in diameter, is judicious, and that in this case also, superior efficiency and economy might be combined by abandoning the present plan. Leaving, however, these points for the present out of the question, and considering the work done within the last ten years, for which we have exact information, it appears that

In the City of London, the increase has been above	13 miles.
In Westminster,	40 miles.
In Holborn and Finsbury (in four years)	21 miles.
In Tower Hamlets	13 miles.
In Surrey and Kent	11 miles.

Making upwards of . . . 118 miles

built in 10 years. Now, the difference in expense between the construction of upright sided sewers with man-holes, and egg shaped or arched sewers, with flushing apparatus, would be about 1800*l.* per mile, or for 118 miles would be nearly a quarter of a million. Large as this sum is, it only embraces a comparatively limited view of this great question; and although I should regret that the financial aspect were the only one under which it should be considered, still it cannot fail to be of value to investigate the subject under that view; and if the investigations were carried closely into every particular in which a saving might be effected by the judicious application of science, the sum which I have so far brought out, would, I believe, be found to be but a part of the extensive economy that would be the result. The money thus saved might be applied to defray the expense of those sanitary improvements, the necessity of which is now so generally acknowledged, but the adoption of which may possibly be delayed, in the fear of incurring great expenditure.

In respect of the strength, how have you found the sewers with upright walls and with arched walls to stand?—No instance of the failure of the arched sewers has come to my knowledge. I have seen one instance near Notting Hill, where the upright sewer had fallen in, been rebuilt, had again fallen, and was rebuilt a third time with extraordinary precautions of piling and strutting, to resist lateral pressure from a slip which was forcing in the upright side walls. Informed of this failure, and knowing that it would offer a useful lesson to the students of Putney College, I took them to examine the work. In one place the whole culvert had slipped bodily with the clay, the form being at the same time distorted. This moving bodily would have occurred with any shaped sewer; but the displacement in the mass was the exception. Usually one of the upright sides, and sometimes both the uprights were crushed inwards towards each other, the invert retaining its position in the longitudinal direction of the sewer. In one place I observed that the invert had been forced upwards when the resistance from the upright walls had been withdrawn.

In those portions which were not carried away bodily by the slip, do you think that the failure, either wholly or partially, arose from any defect in the principle of construction?—I think that the failure arose partially from the want of power in the upright walls to resist lateral pressure so effectually as may be done by arched sides.

Are you aware of the failure of any other sewer of the form which you consider imperfect?—I have not seen any other instance. Mr. Sopwith, the engineer, recites the instance, in Newcastle, of a sewer with upright sides and a flat bottom, which had been built for a quarter of a mile in length. It was crushed, and a circular sewer was substituted, which was found

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to stand well under the circumstances. Such results are no more than what theory and practice would lead me to expect.

It is stated, as a recommendation of the form of the Westminster sewers, that they will stand if the surrounding clay be removed by accident or design. Is not this somewhat like stating that a ship ought to be built so that it might stand upright when out of the water?—Yes; for although I imagine the recommendation to rest upon the known fact that sometimes in sandy wet soil the backing has receded from the upright wall, proper and simple precautions against infiltration towards or from the sewer, would prevent such a contingency, and no provision need be made by the engineer for that which ought not to happen.

If proper science were available, would there be any question as to the shape in respect of strength?—I believe not. I am aware that there are certain physical questions which have been investigated scientifically, and about the results of which investigations much difference of opinion still prevails. But well known theory of the equilibrium of sustaining walls for earth, is universally accepted as true, and is confirmed to be such by its repeated application in hydraulic works, and frequent adoption for culverts, retaining walls, &c. The theory, the investigations of which were first pursued by Coulomb, indicates that a sewer, with an external convex form, to resist lateral pressure, is the most stable. With firm ground the egg-shaped sewer would be the best. For known conditions of varying densities in the external earth modifications from the egg shape would be required, but in no case departing from the application of the principle of the arch. With semi-fluid ground it should approach more nearly to the form of the circle. The egg shape, however, presents this important advantage for the conveyance of water, exclusive of its superior strength and economy, that when the water is small in amount, the narrowness of the lower part gives a greater hydraulic depth, and therefore produces increased velocity; and when the body of water is increased, more capacity is obtained. The superiority of the egg-shaped sewer, in point of strength, is so self-evident, that it really appears a work of supererogation to demonstrate it technically. All grant that the properties of the arch are such as to resist pressure with the least consumption of materials; and, that the outward batter or slope is useful to resist the lateral or inward pressure of the external earth, is an admitted principle, acted upon instinctively by every one. Whoever walks against a strong wind instinctively leans forward against it, being well aware that, with the body in a reclining or sloping direction, he can resist its force better than if he stood upright.

In respect of the superior facilities offered for the free passage of water, have you considered the questions of form and

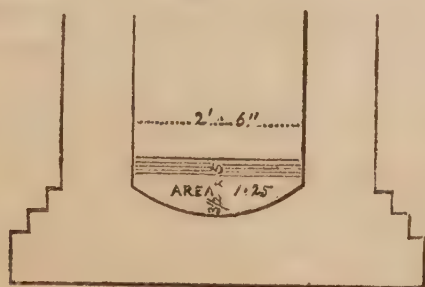
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the mode of junction of two or more sewers, and have you compared the results of practice with the deductions of theory?— I have compared the results offered in practice by the adoption of different forms, and I have found an exact coincidence between those results and the theoretical deductions based on the formulæ of the acknowledged authorities on these subjects. It is a well known law that the friction of water flowing in a channel varies according to the surface of the fluid which, in proportion to the whole quantity, is in contact with the bed of the channel; or, as it is expressed more technically, the friction for any given quantity of water in motion is as the surface of the bottom and sides of the channel directly, and as the whole quantity of water inversely. Combining this with the well known geometrical property, that the circle is the figure which contains the largest area with the least perimeter, and that the more nearly a figure approaches to the form of the circle, the greater is the area of such figure in proportion to its perimeter, it follows, that a given quantity of water flowing through a sewer of a circular form, will meet with less friction, other things being equal, than if flowing through a sewer with upright sides and a flattened segmental invert, and with considerably less friction than if flowing through a flat-bottomed sewer with upright sides.

Have acknowledged writers on these subjects placed the question in such a light as to admit of more correct estimates of the relative advantages than can be offered by the comparatively vague statement that one form is better or worse than another?—Yes. Young, Tredgold, Gytelweyn, and others, have brought the question into such a form as to admit of arriving at certain numerical results with given data. The general proposition established by experiment, that the friction for any given quantity of water in motion is directly as the surface of the channel in contact with the water, may be expressed thus:—Supposing the whole quantity of water to be spread out with a rectangular section, of which the horizontal base would be equal to the bottom and sides of the channel, the height of the rectangle would then vary according to the greater or lesser quantity of water, then the friction varies directly as the base of the rectangle, and inversely as its height. Now, if we compare the three following forms of sewers, viz.—

Fig. 8.

the Westminster—



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the Finsbury—

Fig. 9.

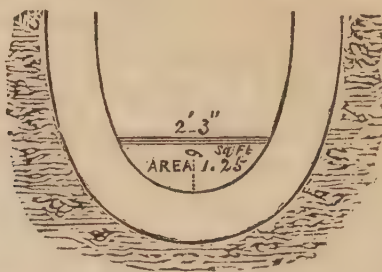
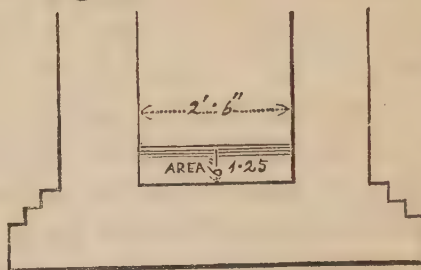


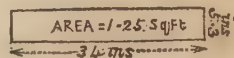
Fig. 10.

a flat-bottomed sewer—

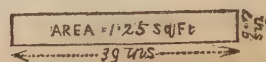


2 feet 6 inches in width, and assume the depth of the current from 8 to 9 inches, or say with a stream of water having a sectional area of 1.25 square feet.

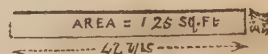
The rectangle of the first will be—



The rectangle of the second will be—



The rectangle of the third will be—



and the relative amounts of friction in each case will be directly as the bases of the rectangles, viz.—

34 39 42;

or inversely as the heights—

53 46 43:

that is, the friction will be in the

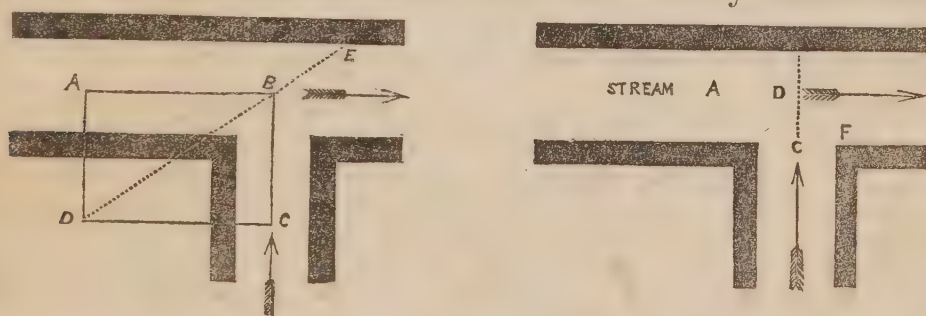
First as	.	.	.	.	.	100
In the second	.	.	.	.	.	115
In the third	.	.	.	.	.	124

We find, therefore, that if, for the sake of the advantage possessed by the Westminster sewers over the flat-bottomed sewers in diminishing the friction, it be judicious to abandon the latter form, there is a greater proportionate advantage in favour of the Finsbury form over that of Westminster, which ought, therefore, to lead equally to the adoption of the former in preference of the latter.

It is stated, and do you believe it to be true, that with the flattened segmental invert, with a certain flow of water, there

will be twice as great an amount of deposit as with the egg-shaped sewer, with the same flow of water?—Yes, especially in cases where the quantity of water is comparatively small and the velocity small also. When the greatest advantage is to be taken of the flow of the water, the egg-shape with the narrow end downwards will be greatly superior to the flattened segment. Substances which would be deposited on the flattened surface will be carried in suspension on the sharper curve.

Would reference to existing authorities demonstrate in a similar manner the injudiciousness of building sewers to meet at right angles?—Yes, writers of eminence on the subject of hydraulics afford the means of guarding against the error of making such junctions, and show that they must produce eddies, and form injurious accumulations of deposit. The well-known theorem of the composition and resolution of forces applied to determine the resultant of two streams of water moving with given velocities, meeting each other at right angles, shows that the resultant would be in the direction of the diagonal of the parallelogram, of which the sides represent the direction and velocity of the component forces. Thus let A B, and C B represent respectively the direction and velocity of two streams meeting at B in the middle of the sewer, the resultant would be in the direction B E of the diagonal of the parallelogram A B C D. But the stream impinging against the side of the sewer in the direction B E, will have its velocity diminished by



the resistance offered, which will likewise cause it to deflect from the longitudinal direction of the sewer, and expend part of the momentum in eddies. The first injurious effects we notice are, therefore, diminution in the velocity, and the production of eddies. Next, it will be found that the meeting of two sewers at right angles must lead to the accumulation of deposit above the point of meeting. For the stream C B being carried in the direction C B will accumulate by its momentum towards the farther edge of the culvert B, where a more violent tumbling motion and eddies will be observed, the point B being found higher than C. By this effect the continuity of the inclined plane, which would mark the upper surface of the stream A D, if it were to flow uninterrupted by the lateral stream, will be broken, and a certain portion of its length extending upwards from D towards A, will become less inclined, or level, or in-

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clining in the contrary direction, according to the greater or lesser force of the lateral stream. But whatever be the amount of diminution in the inclination of the stream at that part of the course, the velocity will diminish according to such decrease of inclination, and as a consequence a deposit will be formed above the meeting of the two sewers. It might be supposed that a deposit would be formed at F, owing to the force of the stream being directed towards the distant part of the sewer; but this is found not to take place to any great amount, because, owing to the accumulation of the water at B, or to the greater elevation of B above F, the velocity at F is somewhat increased by the head of water at B.

Are these theoretical deductions confirmed by practice?—Yes, these direct and necessary conclusions of the application of theoretical investigation to the question are fully confirmed by experience. For in all cases in which the deposit has been examined at the junction of collateral sewers at right angles with the main line, the deposit has been found to extend in a shoal up the stream, the depth of the shoal being greatest at the junction, while immediately below the junction no deposit is seen to accumulate.

Would the opening of gully-holes in the crown of the arch to admit the surface-water of the street into the sewer produce accumulations, and would existing authorities indicate a better arrangement?—Yes, results similar to those described as the consequence of a junction at right angles would follow from the introduction of a gully neck at the crown of the arch. The velocity of the main current would be diminished at the point of meeting, and a deposit would in the same manner, and for the same reasons, be formed on the upstream side. The prevailing plan of forming the opening of private drains first at right angles to the sewer, and secondly elevated 18 inches or 2 feet above the invert, combines both objections, and must cause accumulations at the place of junction.

Would these inconveniences exist in the case of sewers joining at angles less than right angles?—Yes, in a greater or less degree, diminishing, however, with the acuteness of the angle.



Would existing authorities suggest the adoption of curved junctions?—Yes.

Is this a subject which has attracted the attention of writers on hydraulics?—Yes; the ascertaining the expression of resistance due to a bend or curve has engrossed much attention, and has led to the making of numerous experiments. By causing the side sewer to fall into the

main sewer by a curve tangent to the direction of both sewers, eddies are avoided; and when the radius of the curve is of sufficient size, the diminution of the velocity is almost inappreciable.

Can a comparison be made of the degrees of resistance due, 1st, to a junction at right angles; 2ndly, to a curved junction with a radius, say of 5 feet; and, 3rdly, to a junction with a radius, say of 20 feet, with a given velocity and a given size of sewer?—Making use of the formula adopted by Tredgold, and other modern writers, and assuming a velocity of 4.12 feet per second, with second class Finsbury sewers, the following ratios of resistances would be found:—

For a curved junction of 20 feet radius, resistance	100
For a curved junction of 5 feet radius, resistance	. 146
For a junction at right angles, resistance	. . . 316

Then would this result show the propriety of Sewer Commissioners adopting in all cases curved junctions between the side and the main sewers?—Yes; this result shows clearly the objectionable nature of a meeting at right angles, which increases the resistance more than 200 per cent., and makes manifest the great importance of even so small a curvature as one of 5 feet radius. There can be no locality in which such a curvature cannot be adopted with the greatest ease; but as it still produces a result 46 per cent., more retarding than the radius of 20 feet, the latter should certainly be introduced in all new constructions, and in all such old works under repair as would admit of it. With reference to any improvement that might be made by increasing the radius beyond the minimum length allowed by the Commissioners of the Finsbury division, it would of course be well to adopt a greater radius when it could conveniently be accomplished, especially for those sewers which are designed to be the channel of large bodies of water moving at considerable velocities. For the second class sewers, however, the radius of 20 feet will be generally found practically unobjectionable. It appears desirable that further experiments should be tried with channels of different curvatures formed with clay, which channels would be found to become abraded on the concave or outer side by the impinging of the stream; the comparative amount of abrasion would serve as a good test of the resistance offered, and consequently of the proportionate diminution of the velocity.

Supposing the possession of a due knowledge of the laws governing the motion of water, would sewers have been built to join at right angles?—Certainly not.

Do you consider that an officer properly qualified in respect to information, would have been led by reference to already

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existing authorities to adopt egg-shaped sewers and curved junctions?—He would, I think, have adopted sewers protected by the form of the arch in all the parts, varying that form according to the nature of the soil, but usually adopting an egg shape. The peremptory adoption, however, of the egg-shaped sewer, under all circumstances, would be injudicious. For, retaining the principle of the arch, the form of the section should be varied according to the dry or wet nature of the soil. The advantages of a curved junction could not for a moment have admitted of doubt.

Considering the subject of accumulations of deposit in sewers, apart from their supposed noxious influence on the health, would there not be a considerable saving by adopting the system of flushing?—Yes, it would be decidedly economical. The Tower Hamlets, and the Surrey and Kent Commissions, have availed themselves of a modified system of flushing in the sewers contiguous to the Thames, and it is only surprising that the benefits which the districts are reported to have derived from the plan, when adopted, without all the requisite appliances for perfect means, should not have suggested the expediency of adopting the plan over the entire districts. For in the Surrey and Kent Commission, it has been found that in some cases there has been no need, in consequence, of general casting for the last 11 years. As to the economy effected by flushing it would be considerable. The yearly expense of cleansing the sewers has been in—

London, about	£ 500
Westminster	2,000
Tower Hamlets	600

Making a total for three Commissions of . £3,100

There is, in addition, the cost of repairing the pavement where broken up, and the original outlay for man-holes, or apertures for cleansing, which are usually built at distances not exceeding 50 yards from each other. Then to form a fair estimate of the saving that may be the result of a system of flushing; account ought also to be taken of the expense of cleansing deposits from private drains, which expense would not be called for if the private drains were properly built, and the sewers always kept clear. I believe that the saving of, at most, two years, including the doing away with the man-holes, would pay for the erection of the flushing apparatus. The number of loads of deposit removed yearly by carting, is for—

London about	1,500
Westminster about	6,000
Tower Hamlets about	1,800

Making a total of 9,300 loads for

three districts alone, in parts of which a modification of the flushing system is in use, but for the whole extent of which it might be made available.

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Would the present flow of water in the sewers be sufficient to cleanse them by flushing the deposits which are at present found there?—I believe it would. For in those instances to which I have referred in the Surrey and Kent, and the Tower Hamlets districts, it is found that the usual flow through the sewers is sufficient. It acts now in this way; as the tide rises the flaps are closed, and the water is penned back until the ebb removes the pressure. This is found beneficial, but it would undoubtedly be better, if the rush of the stream were made instantaneous. In other districts, showers of rain, without flushing, are found to cleanse the sewers partially. And I need not refer to the well-known example of the Finsbury district, as a proof that the common supply of water, when turned to account, efficiently cleanses the sewers.

Do you think that, in respect of sewers, the utmost limit of economy of materials has been fully obtained, as exemplified in the superior shape you have described? Until recently, it was assumed by engineers supplying towns with water, that earthenware pipes could not be made calculated to resist a high pressure, whereas earthen pipes made of fire clay, one inch thick, and six inches in diameter have been produced, which have stood a pressure of 900 feet, and these may be supplied at one-third of the price of cast-iron pipes of the same bore?—This statement respecting the strength which may be given to earthenware pipes surprises me, and, reasoning from analogy, I certainly believe that we have not yet attained to the most economical construction of sewers, I greatly fear that the paramount importance of combining the utmost economy with efficiency is not kept in view so constantly as it ought to be; for every step made in an inquiry into the matters, proves that the cost of drainage and sewerage acts as an insurmountable bar (under the existing state of things,) to the placing the habitations of the poorer classes in a proper condition. I apprehend that under many circumstances supposed hitherto not applicable, earthenware tubing of various diameters, might be employed for secondary or side-street sewers.

It has been proposed to enact generally that all houses should have 9-inch drains at least, and that the usual private drainage, as now ordered, should be retained. What is your view as regards this proposed legislative provision; and first in the case of the poorer tenements where a sink of two inches, and a spout of three inches supply the drain; and secondly in the case of the better houses, having a soil-pipe of three or four inches, and a waterspout of four inches diameter?—It would

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seem to me objectionable, on the score both of cleanliness and economy, to make it imperative to adhere to a nine-inch brick drain for all houses. The impermeability and superior cleanliness of glazed drain tiles properly fitted one into the other are so important, that when a 9-inch drain is required I would deem the glazed earthenware tubes preferable even in point of ultimate economy; for if the brick drain be set in mortar, the mortar is not unfrequently injured by the passage of impurities, and loses its adhesiveness, and when repairs become necessary it is noisome. But if we compare the relative sectional areas of the soil-pipe and water-spout with that of the 9-inch drain, we shall find that the latter is needlessly large. Taking the diameter of soil pipe at 3 inches (the usual size), the relative proportions of the pipe and of the drain are as 1 to 9; and taking that of the water-spout at 4 inches, the proportions are as 1 to 5. Smaller glazed earthenware tubes would therefore suffice for the conveyance of the liquid refuse, and be more economical.

Exclusively of superior economy, would there be any advantage in a glazed earthenware tubing less than 9 inches in the clear?—For the generality of private houses, the large size of the 9-inch drain acts injuriously in this way, that by spreading the surface of the water in contact and diminishing its hydraulic depth it increases the friction, retards the velocity, and allows of deposits which in time accumulate, choke the drain, and produce those noisome effects which not unfrequently inconvenience the occupiers of even the better class of houses.

What would be the effect if the sink, water-spout, and soil-pipe were all acting at the same time? Would the drain have to be made larger on that account?—The combined action of the three pipes can only be assumed to last a very short time. And, this being the case, the unusual supply of water thus obtained would produce the effect of flushing. The increase in the velocity due to the greater head of water would cleanse the drain.

Then do you consider it a question deserving of careful examination, whether an equally efficient and cheaper substitute might not be adopted instead of the present private drains?—It deserves most careful examination; for in the poorer districts the expense of the introduction of the drains, as required by the existing regulations, acts as a discouragement to their construction, and we accordingly find that owners of private houses frequently refuse to drain into sewers newly made. In the district of Tower Hamlets the private entrances made in new sewers are not more than about 25 per mile, or about one drain for a length of 150 to 200 feet of sewers. In other districts the same unwillingness or apathy prevails among the inhabitants to avail themselves of the convenience of the

sewerage, and in the poor tenements the cost of the drain certainly acts as a drawback against the introduction of the improvement.

A plan that would diminish the cost of the private drains would in your opinion lead to beneficial results?—Yes; and I believe that efficient private drainage might be obtained at a cost considerably less than that which the present regulations demand. It has been stated that glazed earthenware tubes of 3 or 4 inches diameter would cost from 3*d.* to 4*d.* a foot. They might certainly be had at 6*d.* or 7*d.*; and if there were combined with such a drain, a proper supply of water, the tubing would be as efficacious as the 9-inch drains, and would be free from some of the objections to which the latter are liable. In point of draining the saving would be very great. In the City of London the regulations of the Commission provide that the private drains shall be not less than, I believe, 12 inches in the clear. They are usually made from 15 to 18 inches in the clear, at a cost varying from 5*s.* 6*d.* to 6*s.* 6*d.* per foot lineal. In the Westminster district the private drain is limited to a 9-inch bore as the minimum, and is left to be built by the parties requiring the drain, the Commission taking into their own hands the construction of the ring at 10*s.* 6*d.*, and of the first 3 feet at 10*s.* 6*d.*, or 3*s.* 6*d.* per foot. In the Tower Hamlets, where a 12-inch drain is required, the charge is 17*s.* for the first 3 feet, and 3*s.* a foot lineal for the remainder. In the Holborn and Finsbury district a 9-inch bore is the maximum, the cost being 10*s.* for the first 3 feet, and from 2*s.* to 3*s.* per foot for the remainder. In Surrey and Kent, the private drains vary from 18-inch to 15-inch barrel drains at 5*s.* 3*d.* and 4*s.* 3*d.* respectively per foot lineal. The average cost may be taken at about 4*s.* per foot lineal, and as 20 feet may be considered a close approximation to the average length required for each house in narrow streets and overcrowded districts, and from 40 to 50 feet in the less densely built districts, the average length of 30 feet would be a fair standard by which to compare the cost of the present and of the proposed plan. The expense of the present drain, 30 feet, at 4*s.* per foot lineal, would be, with the stone heeling and cement ring, about 6*l.* 10*s.* per house. The same result would probably be obtained for a sum varying from 20*s.* to 30*s.* per house by using tiles of smaller bore, and so great a difference would be of great importance in poor districts. The comparison shows that the enforcing of the 9 or 12-inch barrel drain for private communications ought not to be adhered to, unless perfect certainty of the inapplicability of the proposed more economical plan be established.

It is stated, in a report of the Surveyor for the Holborn and Finsbury Division of Sewers, that it will require about a quarter of a million to defray the expense of setting right the

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sewerage of that district. Do you consider that similar waste must be the consequence of taking drainage and sewerage districts separately?—Decidedly; for, by neglecting the consideration of natural areas of drainage, no provision can be made for the fall, nor for the proper sectional area of sewers. The engineer, in designing for parts only of natural districts, has to decide with incomplete data, and without evidence. First, as regards the amount of water that may be supplied by upland districts, he must have the means of gauging the amount that may be supplied by each converging brook or stream in the natural area, and provide for the free outlet of waters that may accumulate in sudden and heavy showers. The occasional bursting of sewers, and filling of cellars and under-ground habitations which may be noticed in the metropolis, when there has been a continuous fall of about one inch of rain, more or less, shows that such sudden falls of rain must not be neglected as an element in the calculation. Secondly, as regards the free outlet below the district to be drained, levels of existing water-courses must be taken, in order to ascertain whether impediments of a removable kind to the free discharge of the waters exist, and powers should be granted to vary the directions of old channels, especially in low swampy districts, as a more rapid fall can be obtained by abandoning the circuitous course of natural channels, and forming a direct line of drainage.

Do you concur in the view taken by Mr. Sopwith, the engineer, who says, “that any legislative enactment which would render efficient drainage *compulsory* would be of great public advantage; and the cost of construction would be a small proportion of the vast amount of benefit that would accrue in comfort and health to the inhabitants. Proper plans, sections, and levels of all drains, whether public or private, ought to be lodged in a public and readily accessible place, to admit of reference by builders and others. The desultory manner in which new streets are planned is a great preventive of sufficient drains being made. No houses ought to be built within or near a populous town, until a proper approach thereto has been made by a street or road, paved or Macadamized. This arrangement would, generally speaking, be an advantage to all parties. This preliminary and judicious expenditure would increase the value of sites to a vendor, would lessen the cost of building by the facility of conveying materials, and tenants would prefer houses with good approach and sufficient drainage. Thus, all the parties interested would be gainers as well as the public?” —I do. Experience has amply proved that the necessary precaution for health, comfort, and cleanliness, has been and will be neglected by the public. Ignorance of the requisite preventives, and the interference of conflicting local interests, which after the London Fire prevented the adoption of Sir

Christopher Wren's admirable scheme, have always since that time, and will further continue to prevail in baffling the efforts made towards improvement by the enlightened minority. There seems every reason to believe that, unless public provision be made to obtain efficient drainage, the same effects will continue to depress the health and deteriorate the property of all classes, pressing particularly heavily on the poorer classes who cannot protect themselves. For the drainage and structural improvements of old districts, difficulties, no doubt, will exist in the carrying out of any efficient general plan under the control or advice of a competent public authority; but if a well matured plan, accessible to the public, were prepared, and greater facilities for exchange or transfer of small fractions of town property were provided, much could be accomplished without giving rise to complaints. But with regard to new districts, no impediment would, I apprehend, arise. Builders and proprietors would be glad to have access to a well devised public plan, by reference to which they could, without cost or risk of failure, ensure the attainment of proper drainage, and judicious laying out of lines of communication.

Would you extend legislative control to private or house drainage also?—Decidedly, house drainage should be also put under proper regulations, and not left as now to abuse; for this is a question in which one man's apathy or neglect may be not only detrimental to himself, but may prove highly injurious to his neighbours. Besides, the question of sewerage and drainage cannot properly be separated from that of the supply of water to private dwellings. And if you give to dwelling-houses an ample supply of water without efficient means of carrying it off, instead of conferring a benefit, you only add to the mischiefs of miasma, arising from damp and imperfect drainage.

Then, in providing for the drainage by the sewers, account must not only be taken of the supply of water by the natural channels, and from sudden falls of rain, but the artificial supply of private houses must also be considered?—Certainly; when I am informed that the daily supply of London with water is equivalent to the capacity of a lake of 50 acres, 3 feet deep, I see how important an element this becomes in the estimate of the discharge. And so large a quantity (which I would hope to see yet doubled or trebled for the metropolis) may be made instrumental, after it has served household purposes, in cleansing the sewers efficiently, by the adoption of the system of flushing, if needs be.

Would there be any advantage in combining under one authority the drainage, supply of water, and maintenance of roads?—Certainly. The drainage and the supply of water are, in my opinion, so essentially allied and dependent on each other, that I do not understand how they can be treated sepa-

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rately; and the state of the roads and the cost of their maintenance is so completely dependent on efficient drainage, that we have, in the physical facts bearing on the question, an evident necessity for combining all under one management. The advantage of this combination is also made manifest, when we consider that it is only by the combination of various duties of this kind that economy can be ensured, and the command of proper scientific acquirements obtained.

From many parts of the country it has been strongly urged that some security should be taken in respect of the appointment of persons having the management of the works contemplated. If an examination were determined upon to test the requisite qualifications, what ought it to include?—The aim ought to be to obtain persons not only conversant with engineering in general, but who had made an especial study and acquired skill in hydraulic works. I should certainly deem a thorough scientific knowledge essential; for, although some of the most eminent men of the profession have accomplished the greatest works by the strength of their unaided natural powers and clear judgment, such brilliant examples can only be considered as favoured exceptions. The possession of theoretical knowledge could be tested by an examination; but I doubt if mere book knowledge would be sufficient to establish the claims of candidates, for some time to come at least. The examiners should therefore, in my opinion, give due weight to the production of comprehensive surveys, and to reference to successful works of the special kind required. A knowledge of existing works, both in this country and abroad, with an appreciation of the causes of the failures that are sometimes found to occur in very important works, would be a good test. More will sometimes be learned by the careful examination of a work that has failed owing to the existence of perhaps unusual difficulties, but still such as might have been foreseen and provided against, than by the successful construction of works under favourable circumstances. The fall of Newcastle Bridge caused Hutton to write his celebrated tract on bridges, which continues to this day to be referred to as an authority on the subjects treated of. Hutton's case may be referred to as throwing some light on the question. Although not in active practice as an engineer, he was frequently consulted by public bodies on the designs of proposed structures, or the probable stability of existing constructions.

Then you consider that if an examination were determined on, the possession of theoretical knowledge, and reference to successful works, should be required conjointly as tests of fitness?—I name actual practice, because, inasmuch as at present the questions considered by this Commission, have not been much, and certainly not generally studied or mastered by

the profession, a course of examination, and possibly a body of examiners have yet to be formed. But soon, I imagine, that a particular class of hydraulic engineers will arise, who will particularly direct their attention to structural improvements of the character considered by this Commission. Their subordinate employment in that branch will be a preparation for more responsible duties.

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If an examination were not resorted to in the selection of district officers, would professional standing be a sufficient test? —For the subordinate district surveyorships, high professional eminence could not be obtained; still, professional standing would be a good test under certain restrictions; but I would in no case dispense with an examination, and a very strict one too, for the purpose of testing theoretical knowledge. An engineer who had made the subject of drainage, supply of water, and hydraulic works generally, his especial business, would be likely to be best qualified. I say his especial business, because, taking for example the subject of the supply of water and its conveyance in pipes, there are many civil engineers of good standing who have no experience on this point, and who indeed may not have studied the subject, inasmuch as it is not considered generally a branch of the science of civil construction. Yet that would of course be a subject with which the district surveyor ought to be familiarly acquainted.

But a knowledge of hydraulic engineering would not be sufficient?—Certainly not. The person appointed ought to be a practised surveyor, and have skill as a civil architect. To show that the subjects considered in this inquiry will form a new element in the science of engineering, it may be mentioned that warming and ventilation (two operations so influential on the health of the community) are not found in the table of contents of an encyclopædia of architecture. The interest awakened respecting these subjects, by inquiries of the nature of those conducted by this Commission, has certainly directed the attention of some engineers and architects to the important questions of ventilation and warming; but even now the subject is scarcely studied, except by those professional men who have come in contact with the statist, who first pointed out how wide and important a field of operation had been neglected by those engaged in the business of civil construction.

Then how might future increments of towns be designed, in your opinion, so as to promote salubrity by sufficient drainage and ventilation?—I think that this plan of Sir Christopher Wren for the rebuilding of the City of London, may be resorted to, for the sake of illustrating the advantages of proceeding with knowledge and forethought, in laying out suburbs and new districts for towns. It provides for lines of regular drainage and sewerage. It aims at economizing dis-

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tance in communications by diagonal lines. And these diagonal lines by their intersection of all blocks of buildings allow of the free sweep of the winds, and of a more general diffusion of the benefits of exposure to the rays of the sun.

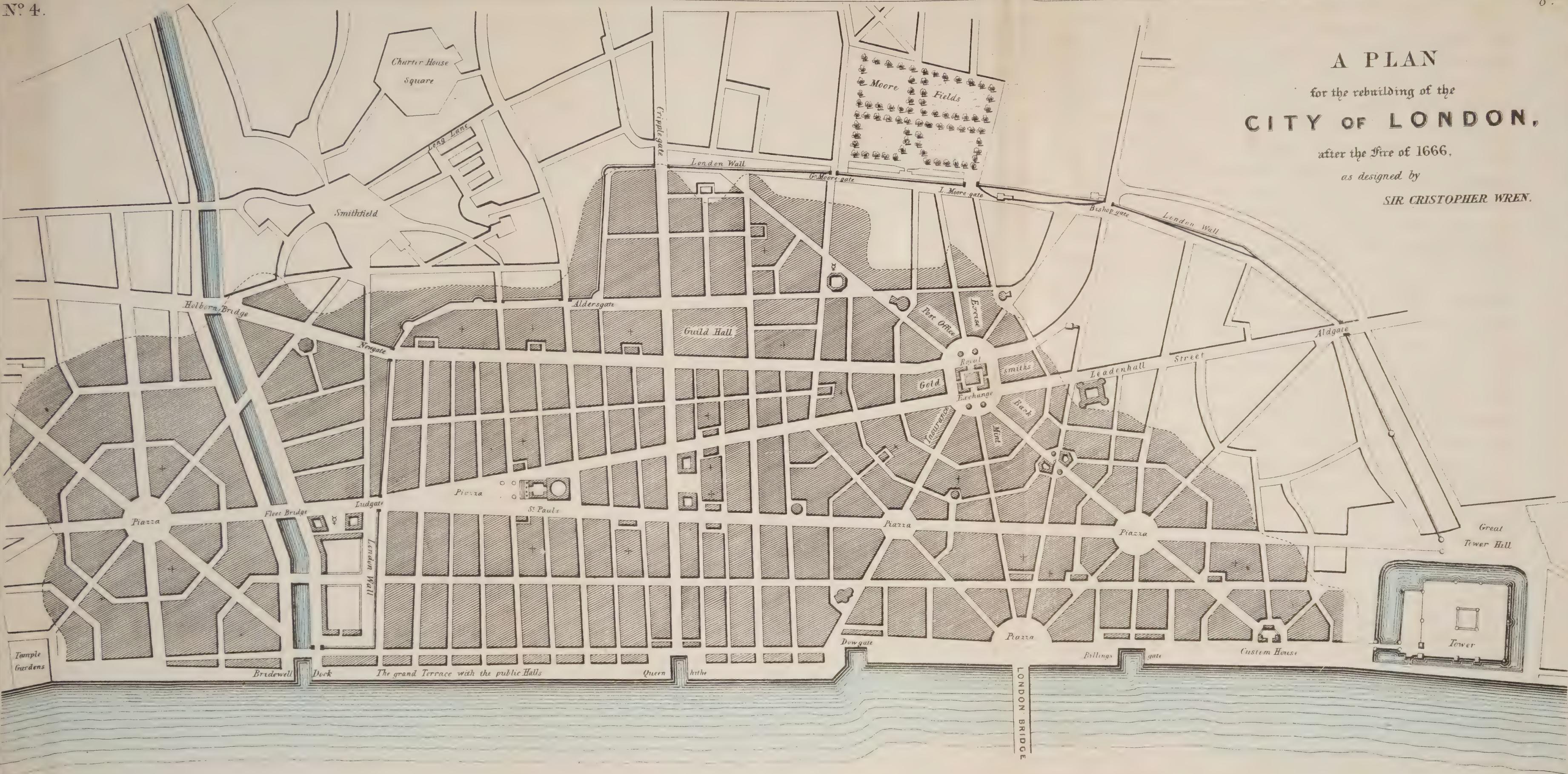
Then, as regards the state of general health, do you concur in the conclusion of the Supplement to the Sanatory Report, that if this plan had been adopted, carrying with it the collateral advantages here referred to, the City would have been in the condition of existing districts judiciously laid out, and where the mortality is one-third less?—I do; for the design would have made the City as open and well drained as those new portions of the metropolis in which we find the mortality diminished in that proportion. If proper regulations affecting the laying out lines of drainage and communication be neglected in the construction of new districts of towns, similarly deplorable consequences must follow; whereas a similar contingent gain will result as a consequence of care and attention to this point at the outset. The rejection of this plan of Sir Christopher Wren's is an example of the disastrous effects of allowing the predominance of ignorance, combined with local and mistaken views of present interest, to countervail the best knowledge, and science, and skill of one competent mind who had mastered the subject. The penalty of this short-sighted yielding to ignorance has been an excess of at least one-third of disease and death above what would have been the probable rate of mortality had the plan of this great man been fairly carried out. The race of citizens has by this self-inflicted increased mortality been swept away, and continues to be carried off, the population of the city being only sustained by immigration. The census returns for 1841 show that, although the population of the city is now less than it was a century ago, about one-half of the present inhabitants are natives of other parts of the kingdom. The returns are as follow:—

	Born in the County of Middlesex.	Born elsewhere.	Not Specified where Born.
City of London within the walls }	29,830	24,050	746

And as the 29,830 given in the return refer to persons born in the county of Middlesex, it is probable that a much smaller number would represent those who were actually born in the City. The state of other corporate towns, and the gross ignorance, excessive waste, and inefficiency shown, almost without one exception, in their attempts to meet the public demands

Nº 4.

A PLAN
for the rebuilding of the
CITY OF LONDON,
after the Fire of 1666,
as designed by
SIR CRISTOPHER WREN.



Map to accompany and illustrate the calculation of annual loss by waste of
time and power in present thoroughfares of the City; and also to be referred
to as an example for laying out suburbs or new districts of Towns.

Butler Williams, Professor of Geodesy
28th March, 1843.

Scale 270 Yards to 1 Inch.

for amendment, establish the conclusion that the intervention of the highest authority of the legislature itself is necessary for the public protection.

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Such a plan would be applicable to new districts, and might have been to the crowded city when the public calamity of the fire had razed it to the ground;—but, in cities as they now stand, and where drainage and ventilation are so much needed, an approximation even to such a uniform and comprehensive plan could scarcely be adopted without creating confusion, and interfering with the intricate properties of a densely populated district?—No doubt the difficulties in such a district are great, but they are by no means insurmountable. The improvement which has within the last few years taken place in Paris, (in which the evils arising from the want of space are greater than in the most crowded parts of London) is so striking, and the method pursued leads to so few complaints as to hold out the promise of a rapid advance in the same direction. A comprehensive plan of the City accessible to the public, and approved and sanctioned by the municipal authorities, indicates the improved and widened lines of streets to which houses when rebuilt must conform, and in their tortuous and narrow thoroughfares, are to be seen from distance to distance, new houses built, or being built, from 5 to 10, or 15 feet back from the old frontage, and in such directions as (when all the houses shall have been rebuilt) ultimately to present regular instead of the existing tortuous lines, which, by the irregular projection, and retreating of the houses, interrupt the traffic and impede the free sweep of the winds. In every district of their crowded city, promises of the ultimate widening of their streets (in the same way as that of Newman-street, in the City of London) are to be observed. The compensation for the ground thus ceded for the widening of the public ways is fixed by juries of “experts;” and there seem to be but few complaints against the mode of assessing the rate of compensation. When Sir Christopher Wren designed his plan for the rebuilding of London, it was his especial aim to combine with it the avoidance of loss to any man, and to guard against the infringement of any property; or, as stated in the *Parentalia*, “such a method was proposed, that by an equal distribution of ground into buildings, leaving out churchyards, gardens, &c., (which are to be removed out of the town) there would have been sufficient room both for the augmentation of the streets, disposition of the churches, halls, and all public buildings, and to have given every proprietor full satisfaction; and although few proprietors should happen to have been seated again directly upon the very same ground they had possessed before the fire, yet no man would have been thrust any considerable distance from it, but been placed, at

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least as conveniently, and sometimes more so to their own trades than before."

How might provision be made for ventilation and the free sweep of the winds through the blocks of houses?—A minimum size, varying with circumstances of locality and heights of houses, should be fixed for the width of the streets, which would be made broader in flat and clayey districts, and with high buildings, than would be necessary on hilly and gravelly or porous soils, or with low dwellings. Under all conditions of natural formation, care should be bestowed on designing the lines of streets so as to expose the houses to the most complete influence of the sun, as well as to the free sweeping of the wind. The building of houses back to back should be avoided. The influence of the sun, in producing and sustaining ventilation, had been noticed by Vitruvius, who in the selection of sites for theatres and public buildings directs especial attention to the aspect of such buildings, as having an influence on the circulation of the air.

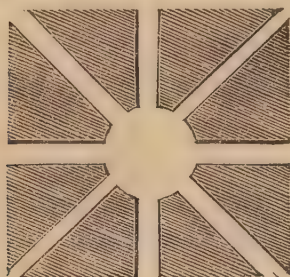
Then you consider that Sir Christopher Wren's plan for the city illustrates the advantages of diagonal lines of communication, of a more general exposure to the sun's rays, of a more perfect ventilation, and of pre-appointed regulations to guide in the growth of new districts?—Yes. As regards the access of light and air as provided for in the design, a modification of the same principle, in laying out lines of communication, has been applied by Mr. Loudon in his work on suburban gardening. If the streets of a town have only north and south, and east and west directions, there will be a very unequal distribution of the benefits of solar light. The rows of houses placed in a direction parallel to a street running north and south will receive the sun's light on the front and rear on every day on which he shines; but the houses built on the north and south sides of a street running east and west, will have in each row only one side of the houses exposed to the sun's rays. The great influence of direction may be very frequently noticed in the streets of London which extend in an east and west direction; the half of the street next the south side, and which is almost always in shade, is almost always damp; and when the fronts of the houses are covered with stucco, the effect of the damp is strongly indicated in the difference of colour between the façades of the houses on the north and the south sides. Now diagonal lines of streets intersecting these in north-west and south-east, and north-east and south-west directions, will enable all the houses to receive, in an equal degree, the benefit of the sun's rays, both on the front and back. With single or double detached houses, such as are built in suburbs, the advantages derivable from the diagonal directions recommended become still more manifest; for with these both the sides and the front

and back will be exposed to the sun's rays every day throughout the year. When houses are built back to back, and in rows extending in an east and west direction, those rows which are on the south side of the street do not receive any benefit whatever from the direct rays of the sun, and they must unavoidably be cold and damp and more imperfectly ventilated, from the sun's heat not contributing to rarefy unequally and in succession different parts of the air.

These remarks have reference to increments of towns, or to the building of new districts of towns?—Yes. Even were there small hope of rendering more salubrious the streets and buildings of an old city, it would yet be useful to expose fully the evils which result from their injudicious arrangement, in order that errors of the same kind may be avoided in the designing of new towns, or the increments of old cities. And in the canvassing of the respective merits of various plans, ventilation of the streets and buildings, and the reservation of public walks and open spaces should hold a most important place. It is really surprising to witness with what complete disregard of these considerations new districts, built for working men and manufacturing classes, are designed. While the public concur to a man in lamenting the past neglect on this point, it seems that for all, except the habitations of the wealthy, its importance is yet completely disregarded in practice. Even in suburban districts of the metropolis, laid out for the habitations of the wealthy, there is sometimes great ignorance displayed of the common precautions against miasma. On the Surrey side of the river, sheets of stagnant water, preserved for ornament, are in close proximity with otherwise agreeable residences, which must surely be rendered insalubrious by the exhalations of the surrounding tanks. Even if the sheets of water to which I refer were merely stagnant, that alone would render them unhealthy. But when, in addition, it is considered that they are connected with brooks or streams loaded with the refuse of many houses (and which, in fact, as they approach the Thames, become, more properly speaking, open sewers, giving out, in certain seasons, intolerable exhalations), an idea may be formed of the injury which must accrue to the inhabitants from such a state of things. At high water, especially in spring-tides, the waters of these open sewers are forced back, and made to regurgitate into the tanks designed solely for ornament. Supposing a new district of a town to be laid out, the proprietors or projectors would learn much by consulting Sir Christopher Wren's plan. To secure ventilation the streets should be straight, and should radiate from a centre. They will then open directly on the surrounding country; thereby the air will be most readily and continuously changed, and the pure atmosphere of the fields will rush directly through the

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town, attenuating the noxious gases, and revivifying the used air. The proposed arrangement of diagonal lines affords the most direct access to various distant points, as is proved by the great radiating lines of road which have been opened on



the south side of London. The angles whence the streets diverge might be appropriated as sites of public buildings, and may be rendered thus highly ornamental, while it is doubtful whether it would not be at all times preferable to leave the central space open, or occupied only by gardens, or a fountain, or pillar,

than to allow its value as a free breathing place to be diminished by having it occupied by any public building. Public buildings might be made to appear to as great advantage at the sides, and by such an arrangement the central ground would be preserved for light, fresh air, and exercise; or, for that which has been aptly called the "mere luxury of space." Sir Christopher Wren's plan will be found also to exhibit the practical application of the normal polygon, which has been described in Captain Vetch's Report on the Increments of Towns, printed in the Appendix to the Sanatory Report.

You have stated that contour lines would serve to guide in the improvements of the levels of streets, when repairs of the pavement would offer opportunities of reducing at small cost the irregularities in the gradients. This observation would apply to old as well as to new districts of towns?—With respect to old districts, improvements of importance might be accomplished without interfering with the convenient access to houses, and at very moderate cost, by taking advantage of the re-pavement of streets to level or reduce by a few feet the mere surface irregularities such as may be noticed in many of the thoroughfares of the metropolis. In the re-pavements of streets, as generally conducted at present, the old curves following the existing irregularities of the surface are retained; whereas not unfrequently an excavation of even so little as one or two feet at one point, and a corresponding filling of one or two feet at another point, would remove irregularities which, so far as they go, are objectionable. Every foot reduced in the rise of a thoroughfare open to great traffic produces a corresponding saving of power by no means unimportant. I have had occasion to obtain, with reference to this subject, returns of the traffic in several of the streets of the City of London, and as deductions based on the returns bring out forcibly the importance of not neglecting any opportunity that may be afforded by the re-pavements to reduce from time to time irregularities of the surface, I would, with the permission of the Board, refer to some of these results, although I must admit that the process

of demonstration is somewhat long, and necessarily embraces some statistical details. I give these statistical details also in connection with the map No. 4, in order to show how much must be embraced directly or indirectly in these investigations, and what important consequences are the result of combinations of causes, in themselves not very influential, when they are made to bear on large masses of the community. They show that you must have men of extended views, capable of embracing all the elements that combine to produce the results sought to be obtained; and that it can scarcely be expedient in most cases that persons of limited education should be called upon to decide on important sanitary measures. Mischief cannot but be the consequence, and this plan of Sir Christopher Wren's is a great monument of the truth of these observations. Confining attention to the thoroughfares of Holborn and Ludgate-hill, I have been able, by reference to the plans submitted, and by means of the contour lines embodied on one of them, together with the returns of the daily traffic, to establish that, in consequence both of the inclinations and irregular or crooked directions of the streets, the loss incurred in carriage traffic alone, on the two main lines of street referred to, amounts to about 100,000*l.* per annum. The paper submitted is an abstract of the data on which the estimate of this loss is founded.

In estimating the cost of the traffic, you have taken the returns of the present rates. Would not improvements in the levels of the streets and in the superstructure that would materially diminish the draught, tend to reduce the fares or charges for the use of carts, waggons, or other vehicles?—Yes, if the streets were made level and their superstructure improved, no doubt the fares and rates of charges on all vehicles would be reduced; but in making the comparison referred to, I have taken no account of this supposed contingent decrease in fares and charges, because the community at large would derive benefit from such decrease, and if allowed for in the estimated excess of expenditure caused by gradients, it would have to be taken into account as an advantage to the community exactly equivalent to the money saved, and would still be, therefore, the saving due to the supposed adoption of Sir Christopher Wren's plan, as deduced from the preceding returns and calculations. This amount, however, must fall short of the sum that would actually be saved, because in the estimate of loss by distance no account could be taken of the loss incurred by the circuitous route usually adopted for heavily laden vehicles, for the purpose of avoiding the steep gradients under consideration. The proportion of vehicles that are thus diverted from their direct line of streets must be considerable: the carriers referred to for information on this head stated, that they never allow

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their heavily laden waggons to pass through Holborn, for example, if they can arrive at their destination by following the lines of more level streets, as they consider the loss by increase of distance less important than the injury caused to the horses by over exertion, from the comparative view of the two conditions of the streets. In estimating the loss by distance and by gradients, the returns used for data referred only to traffic passing through Holborn and through Ludgate. I have assumed the traffic as being in Skinner-street equal to that of Holborn, and in Fleet-street equal to that of Ludgate; and, in the absence of more exact data, this assumption appears reasonable. In estimating the loss by distance, I have on a similar principle assumed that all who passed by the locality to which each return refers, were passing to or from the Bank.

Col. Colby, R.E.

COPY of a LETTER from Colonel COLBY, R.E., to the Inspector-General of Fortifications.

*Ordnance Map Office, Southampton,
13th March, 1844.*

SIR,

IN obedience to your minute of the 21st ultimo on the Master-General's order of the 19th ultimo, I have called on Captain Tucker to furnish the best estimates his local experience in directing the detail survey of towns can supply, of the cost of the classes of survey and plans required by the Commissioners for the Health of Towns.

With reference to the third class, viz., when the survey has not been commenced, fourpence halfpenny per acre must be added to Captain Tucker's estimate for the fixation and calculation of points to lay down the detail survey with accuracy; this I have added in a supplementary column on Captain Tucker's estimate.

In Captain Tucker's estimate he has not included the expenses of removing parties and instruments to the towns to be surveyed, or the hire of offices, because such expenses are manifestly contingent on the order in which the surveys of towns may be required.

If the surveying parties are at work in the vicinity of the towns required to be surveyed, these contingencies will be quite trivial; if, on the contrary, distant towns are required to be surveyed in succession, the expenses of removal will be great in comparison with the cost of the surveys.

The cost of laying down sewers and gas-pipes will also depend greatly on the knowledge of their positions possessed by the inhabitants, and on the facilities they afford to the surveyors;

and in all cases the cost per acre will be increased if the surveying parties are so small as to spread the work over a considerable length of time. Col. Colby, R.E.

I have the honour, &c.

COPY of a LETTER from Captain HENRY TUCKER, R.E., to Colonel COLBY.

Capt. Henry
Tucker, R.E.

Ordnance Survey Office, York,
8th March, 1844.

SIR,

IN obedience to your order of the 22nd February, 1844, I have the honour to submit the following estimates for the Health of Towns Commission, plans on the scale of five feet to one mile, showing contour altitudes, or altitudes marked at equal vertical distances, in the streets of towns, contour lines without the towns, sufficient to be serviceable for the sewerage and drainage of them, and including the expense of ascertaining sewers, water-pipes, and gas-pipes, arranged under the following heads:—

- 1st. Of towns of which the survey is completed.
- 2nd. Of towns of which the survey is in progress.
- 3rd. Of towns of which the survey has not been commenced.

No. 1. *Towns Surveyed.*—In the estimate under this head the expense of the surveying and levelling already done is not included, as I have considered them to have been performed for the Ordnance Survey, therefore I have only charged the additional expense of marking contour altitudes *in* the streets, and contour lines *outside* the towns, ascertaining sewers, water-pipes, and gas-pipes.

The cost of making copies of the plans is inserted, to which the additional cost is added to show the cost of copies of the plans with the additional information for sanitary purposes.

No. 2. *Towns in progress for the Ordnance Survey of England.*—The estimate for levelling and marking contours *in* the streets is for the levelling which will be necessary for the improvement of the sewerage and drainage of towns, supposing it to be done for that purpose.

The cost of copies of the plans is the same as for Class No. 1.

No. 3. *Towns of which the Survey is not commenced.*—The surveying, plotting, and drawing are charged, showing the cost of levelling, contouring, ascertaining sewers, water-pipes, and gas-pipes, as in No. 2.

The expense of fixing points is not included in the estimate.

The expense of surveying varies in proportion to the size or population and the compactness of the town.

Capt. Henry
Tucker, R.E.

The area or extent of the close or compact part of a large town being greater in proportion to the whole area or extent of the town than the compact part of a small town bears to its whole area or extent, the cost of surveying will be greater in proportion to its area than the cost of a small town, therefore I have estimated the cost of preparing plans of towns having a population of 10,000, 20,000, 50,000, 100,000, and 300,000.

The levelling and marking contour altitudes in the streets embraces the showing the water-shedding lines, and the lines of natural drainage, as accurately as the sinuosities of the streets will allow of their being traced, and the levelling is supposed to be arranged for that *particular* object, as contour lines cannot be laid out within the towns; showing also a sufficient number of contour altitudes to connect altitudes marked along the line of drainage with equal altitudes marked along the water-shedding lines.

The expenses of levelling and contouring are estimated for towns situated on gentle slopes, For abrupt slopes the expense of levelling will be nearly one-third greater, but the contour altitudes in the streets will be at greater vertical distances, and fewer contour lines will be laid out.

I have considered the towns of 10,000 and 20,000 inhabitants to consist of long branching streets with few cross streets, and requiring less levelling than towns that are compact with numerous cross streets.

The expense of contouring or marking the contour lines outside the town is calculated on the supposition that one-third of the whole area, usually included on the Ordnance plans, will admit of their being laid out, and the expense shown in the estimate is the average expense per acre for the whole area of the plan.

The levelling performed at Windsor cost 6·5*d.* per acre, including the levelling for four lines of sections in addition to that which would have been sufficient for sewerage and marking the contours.

The contouring cost 2·75 per acre.

The contours above the datum mark at the bridge are laid out at four feet vertical distance from each other.

Those below the datum point at two feet vertical distance apart.

The expense of contouring was much increased by the necessity for laying out and surveying the lines before the plan was drawn, in order to complete them before Her Majesty's return to the Castle, which caused an increase of 0*d.*75 to the expense.

The cost of contouring Windsor exceeds the expense per acre, shown in the estimate for towns, arising from the large extent of country in proportion to the area covered by the town, the contoured area being three-fifths of the area of the plan; whereas

in the estimate for plans of towns the space or extent of ground on which it will be possible to lay out contour lines is supposed to be one-third only of the area of the plan.

The cost of ascertaining the sewers, water-pipes, and gas-pipes of Windsor, and the Castle, and putting them on the plan, amounted to 1*d*.3 per acre for the space occupied by the town.

The sewers, water-pipes, and gas-pipes of Manchester have not been ascertained.

The cost of obtaining them for the town of Oldham amounted to 1*d*.1 per acre.

The sewers and water-pipes, but not the gas-pipes, have been ascertained for Bury at the expense of 0*d*.28 per acre.

The plans of Oldham and Bury are not sufficiently advanced for the insertion of the sewers, therefore the expense of putting them on the plan is not known.

The expense of ascertaining the sewerage, water, and gas-pipes, varies according to the facilities given by the local authorities in appointing persons to show their position and the quantity of the sewerage; some places being very deficient, and few or none possess plans.

There is not a plan of the sewers of Oldham, and only one man, 80 years of age, could be found who knew the situation of a principal sewer.

I have not included contingent expenses, as office rent, conveying parties or stores, as, should the Commissioners wish to undertake the surveys of towns, these expenses will depend on the strength of the party or parties employed, each of which, I think, should consist of 16 to 20 *surveyors*, to be divided into two parties; when the towns nearest to each other are small, or to be employed as one party if a town be large, that the survey may be promptly executed.

I have the honour, &c.

ESTIMATE of the Cost per Acre of Five Feet Plans of Towns.

Population of the Towns.	FIRST CLASS. Copies of Plans of Towns, of which the Surveying and Levelling are completed.						SECOND CLASS. Copies of Plans of Towns, of which the Levelling is not commenced.						THIRD CLASS. Plans of Towns, of which the Survey is not commenced					
	Additional Expense per Acre for			Total additional Expenses.			Expense per Acre for			Expense per Acre for			Expense per Acre for			Total Cost of Plans, per Acre.		
	Cost of a Copy of the Ordnance Plan, per Acre.	Contour Altitudes in the Towns.	Contour Lines without the Towns.	Sewers, Water, and Gas Pipes.	d.	p.	Levelling and Contour Altitudes in the Towns.	Contour Lines without the Towns.	Sewers, Water, and Gas Pipes.	d.	p.	Surveying.	Plotting and Drawing.	Levelling and Contour Altitudes in the Towns.	Contour Lines without the Towns.	Sewers, Water, and Gas Pipes.	Total Cost of Plans, per Acre.	Total Cost of Plans per Acre, including the Fixation and Calculation of Points
10,000	8	1.5	1	1.5	d.	8	4	1	1.5	d.	14.5	12	21	4	1	1.53	3.5	8
20,000	9	1.5	1	1.5	d.	9	4	1	1.5	d.	15.5	15	22	4	1	1.53	7.5	0
50,000	11	2.0	1	2.0	d.	11	5	1	2.0	d.	19.0	21	25	5	1	2.04	6	4 10½
100,000	12	2.0	1	2.0	d.	12	5	1	2.0	d.	20.0	28	29	5	1	2.05	5	9
300,000	14	2.5	1	2.5	d.	14	6	1	2.5	d.	23.5	49	32	6	1	2.57	6.5	11

